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Edited by
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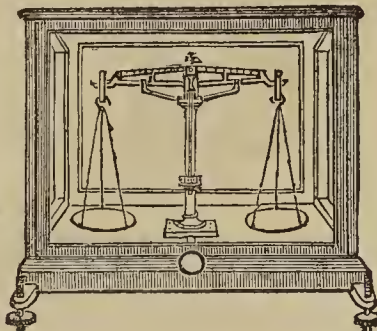
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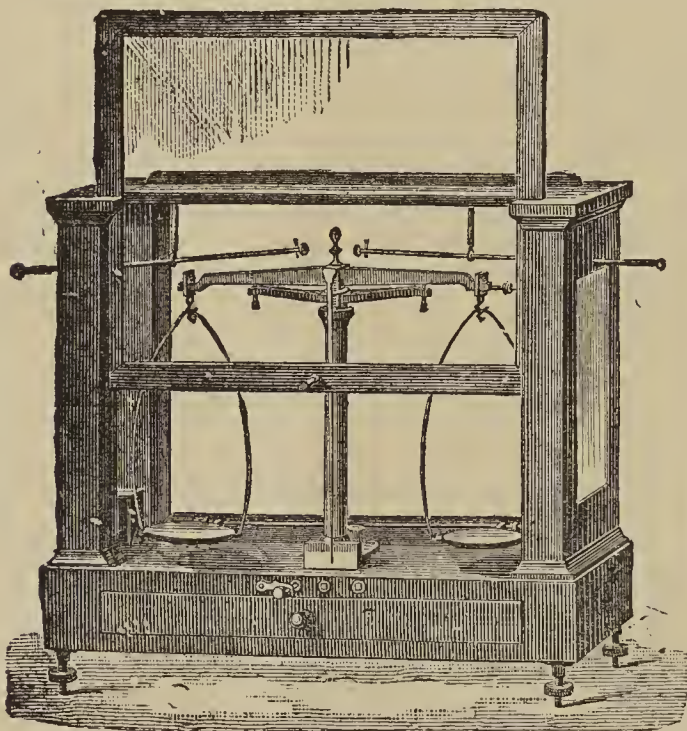
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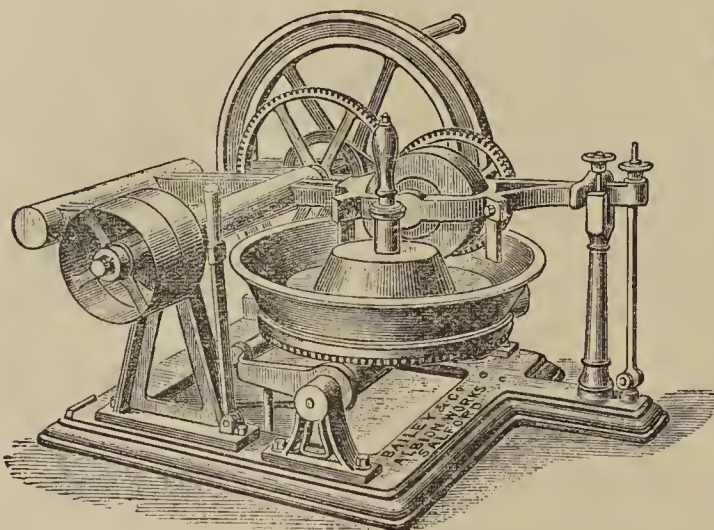
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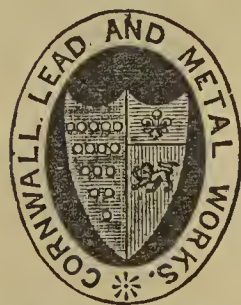
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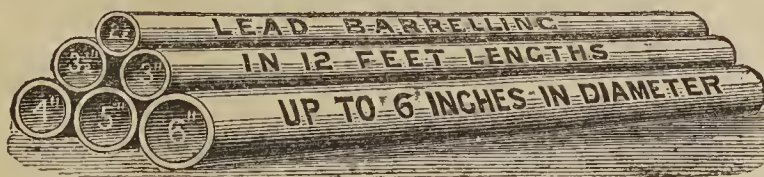
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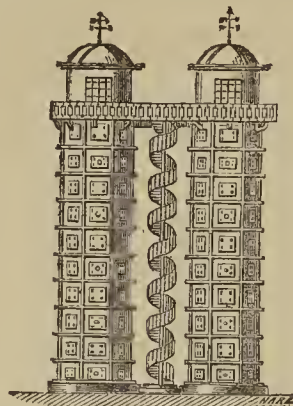
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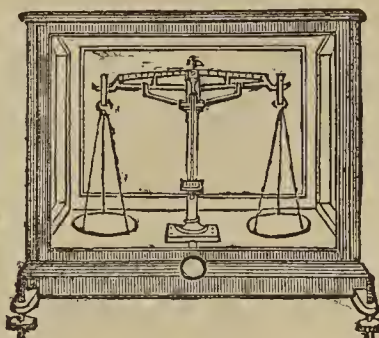
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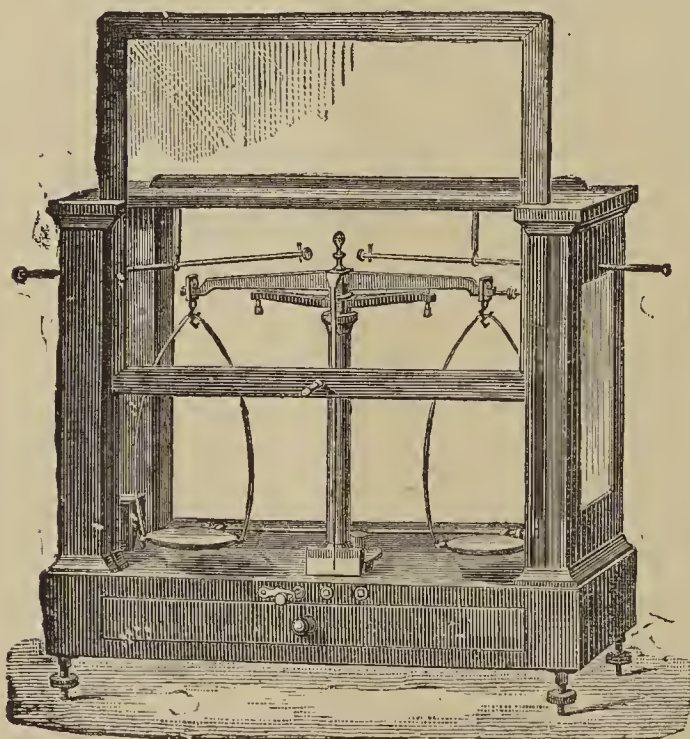
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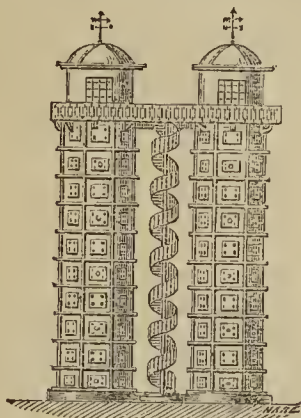
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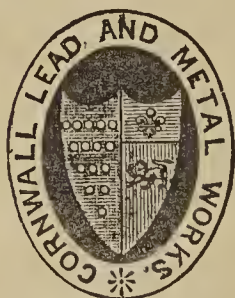
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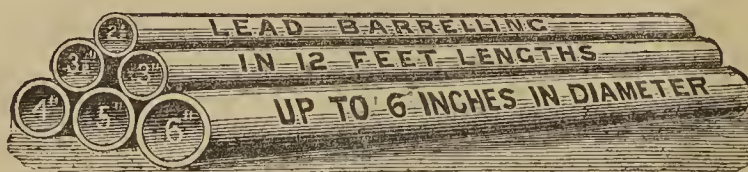
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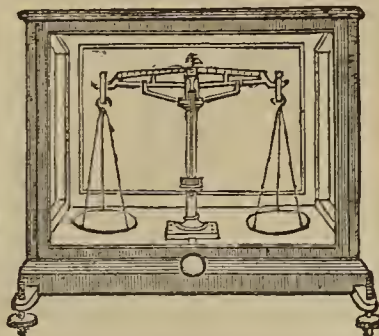
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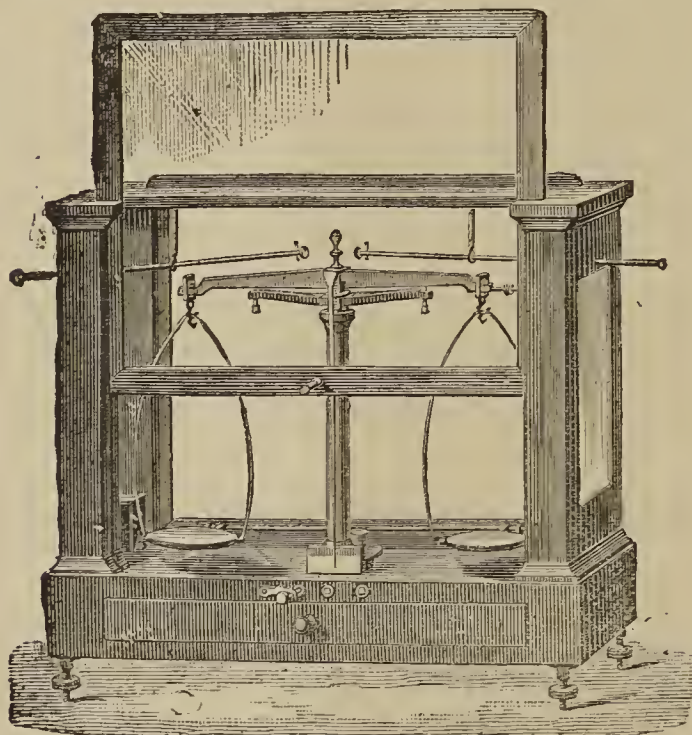
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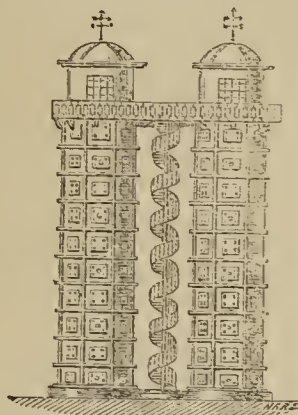
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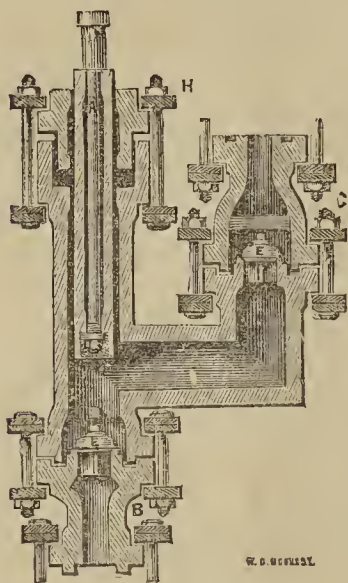
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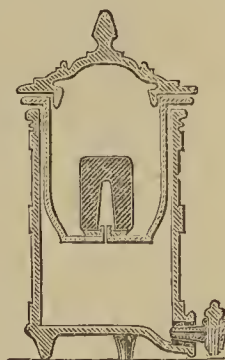
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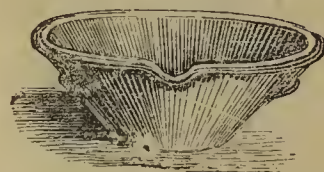


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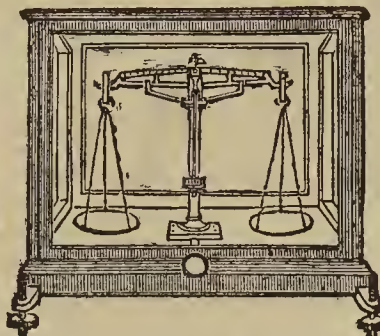
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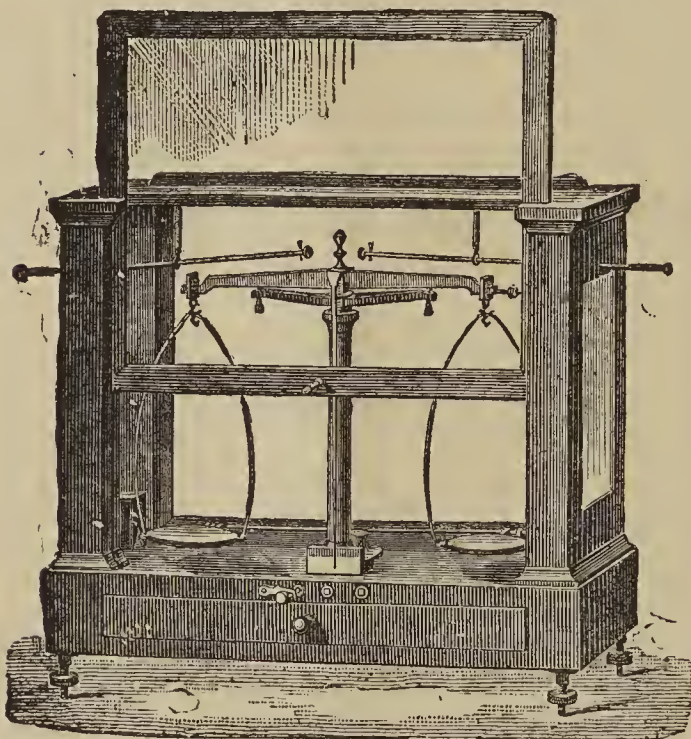
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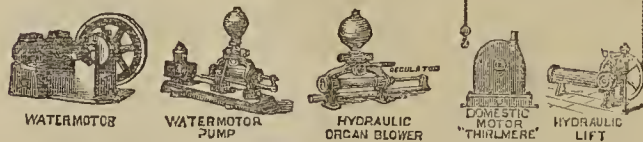
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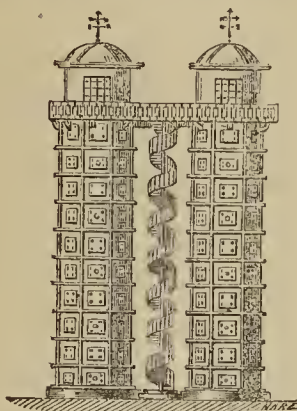
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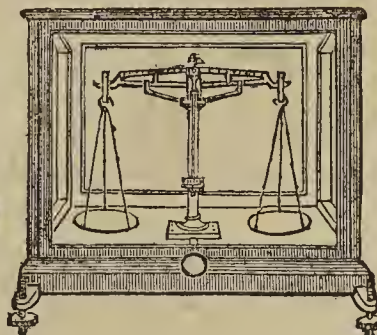
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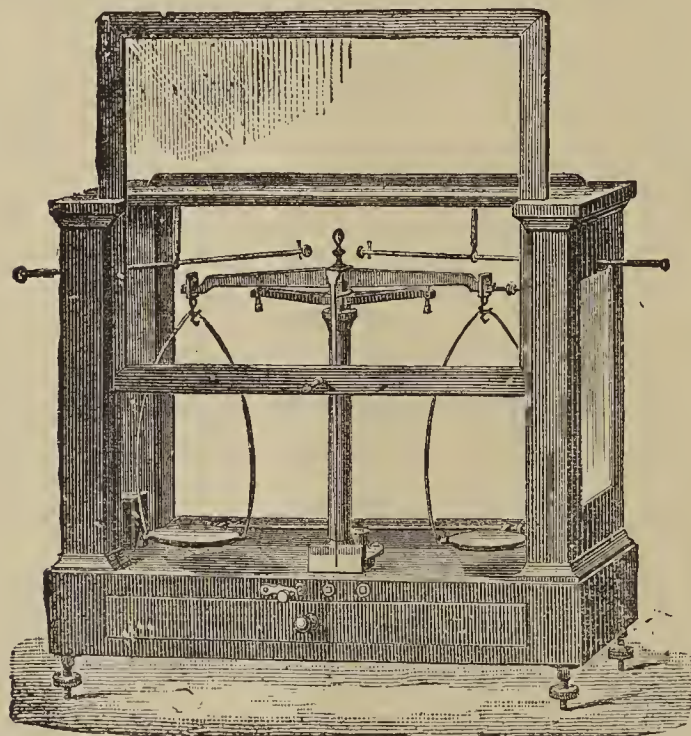
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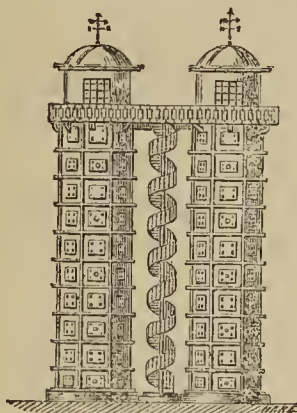
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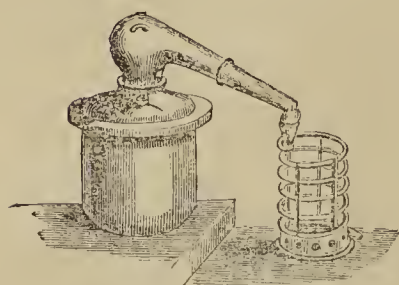
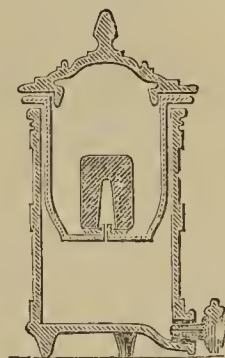
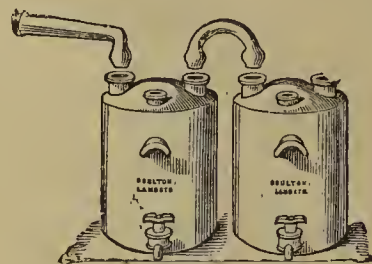
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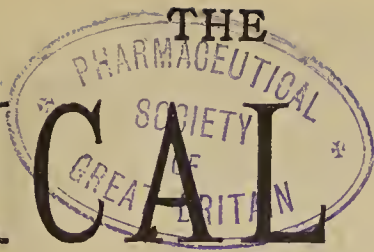
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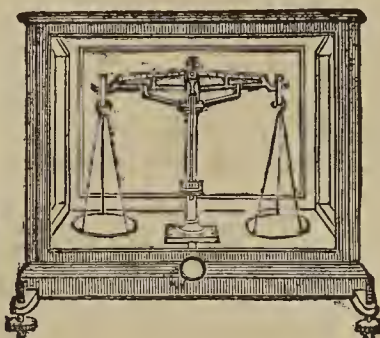
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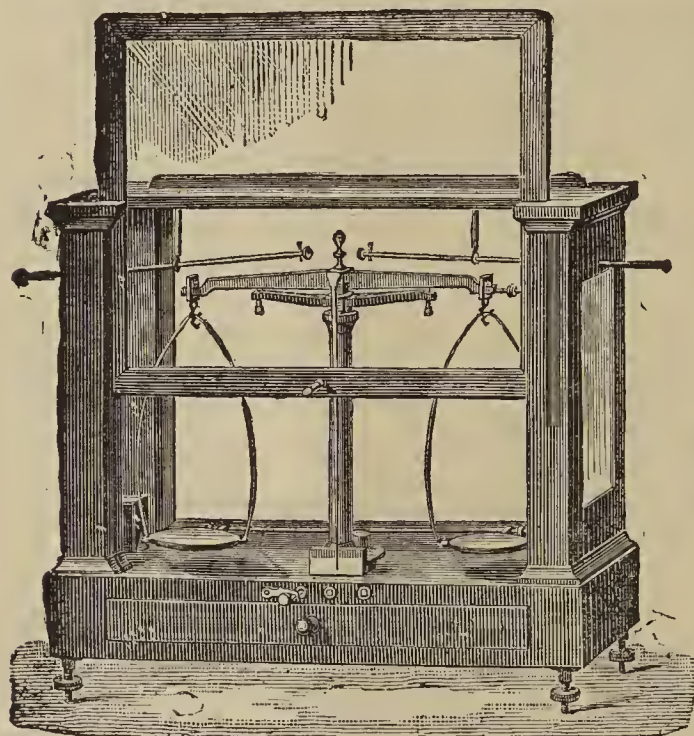
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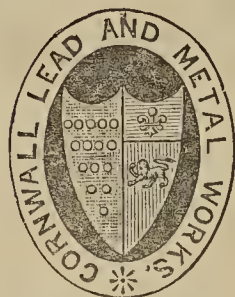
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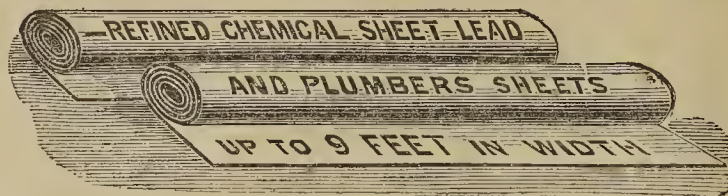
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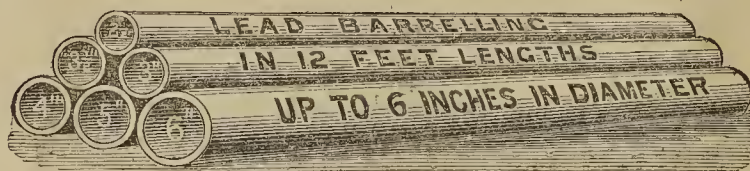
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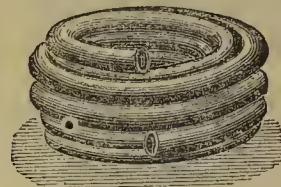


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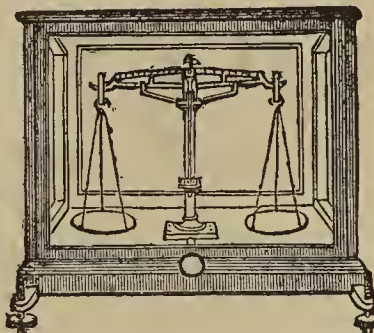
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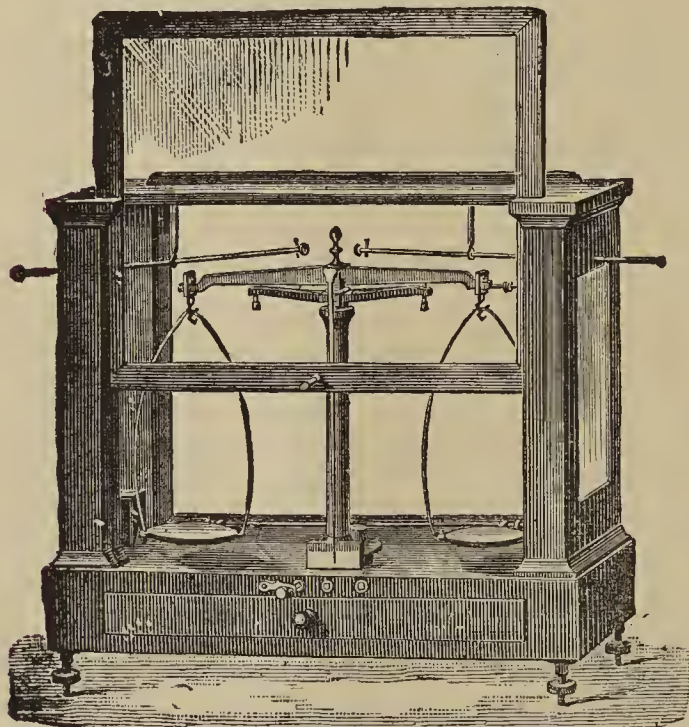
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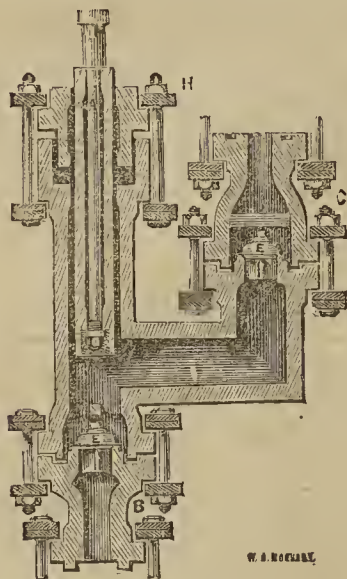
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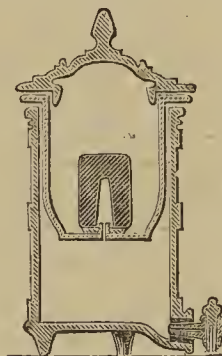
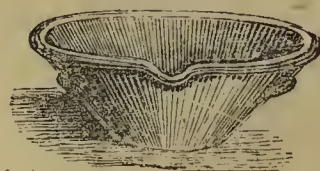
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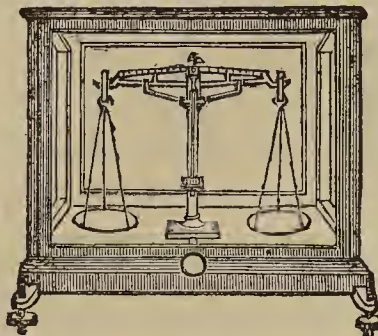
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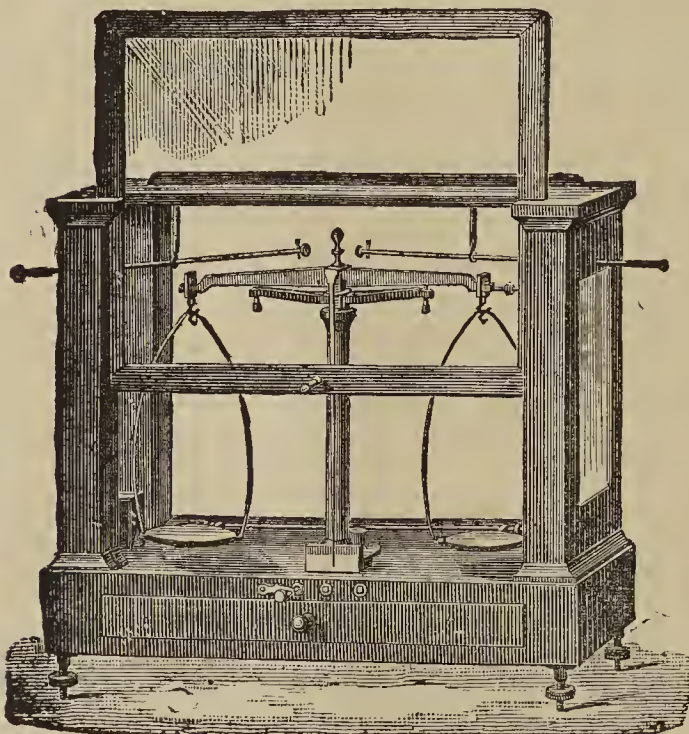
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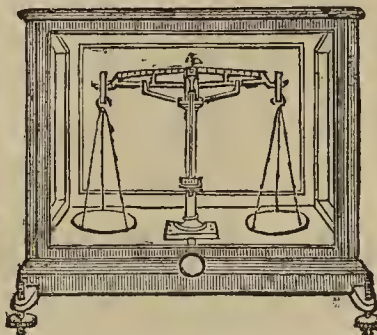
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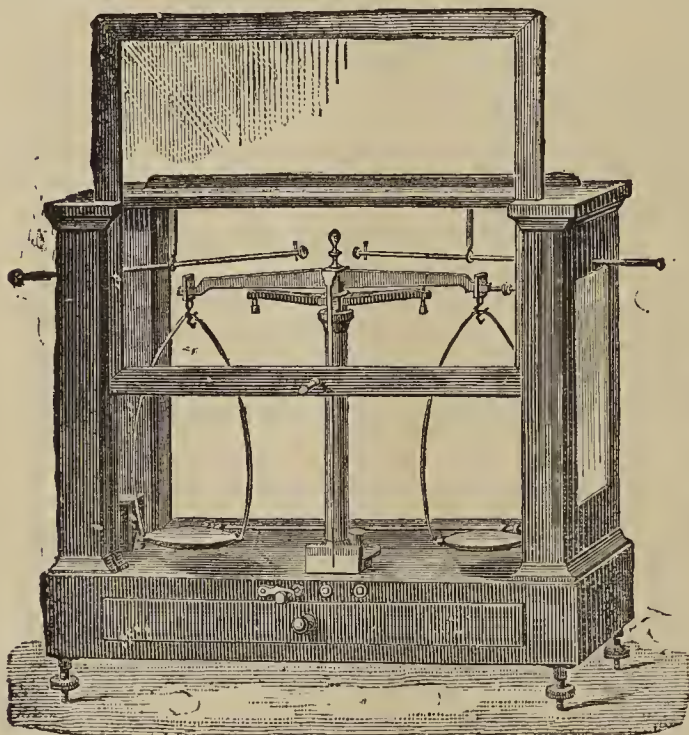
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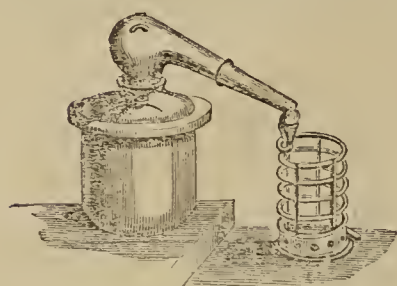
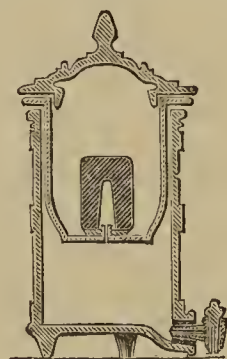
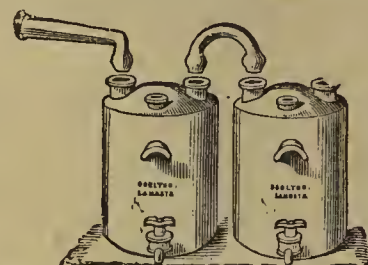
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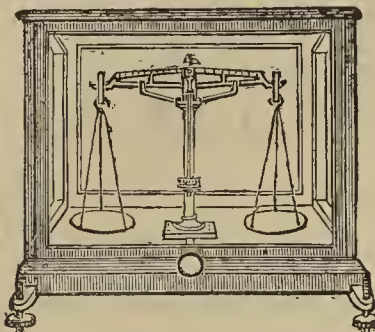
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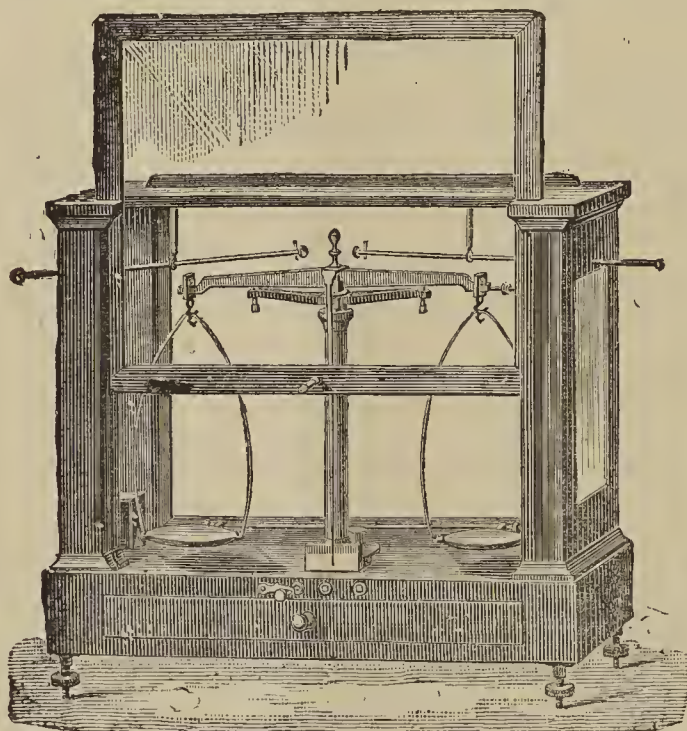
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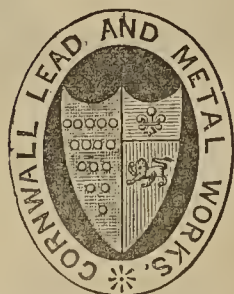
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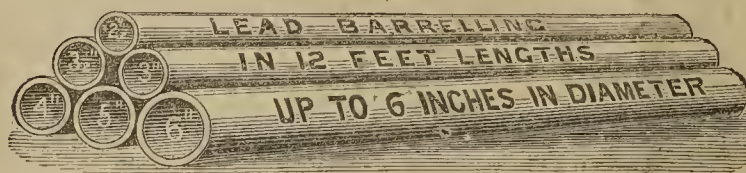
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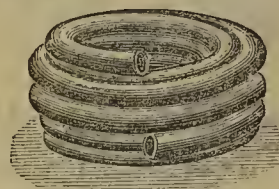


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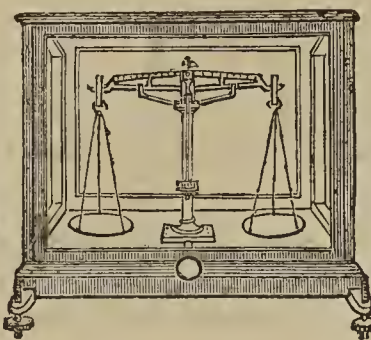
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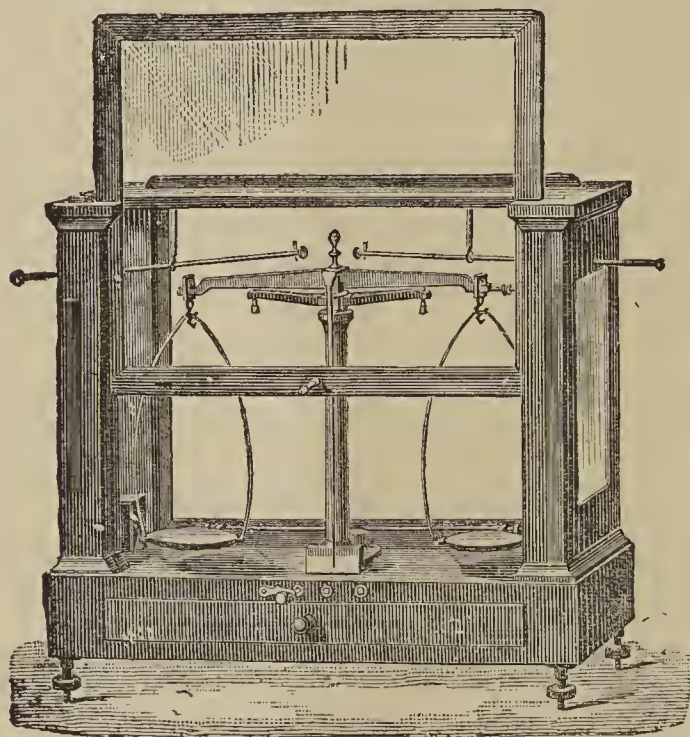
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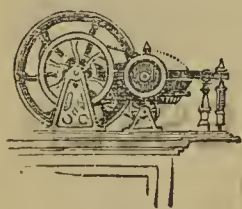
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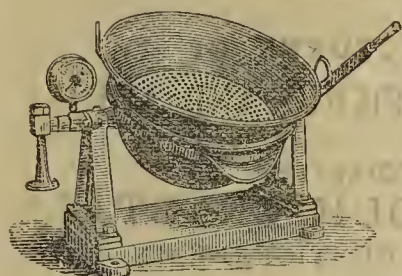
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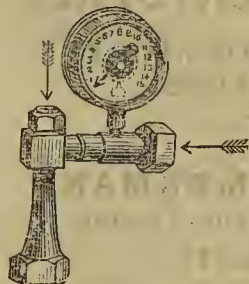


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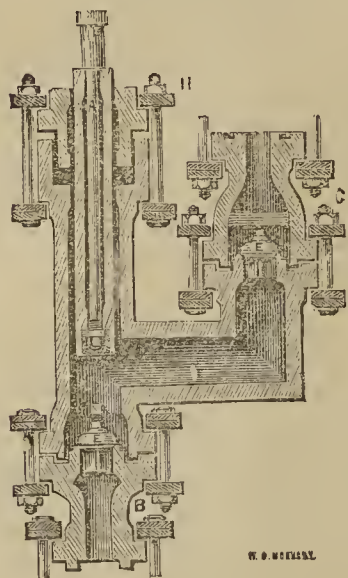
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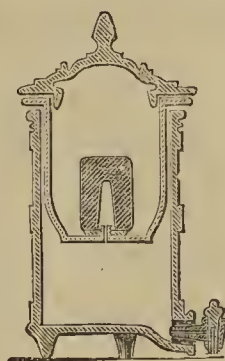
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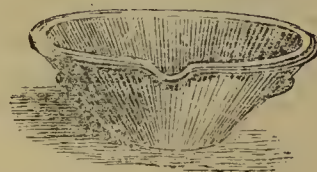
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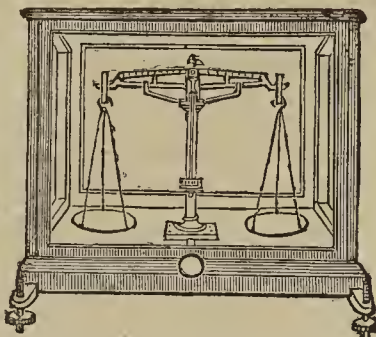
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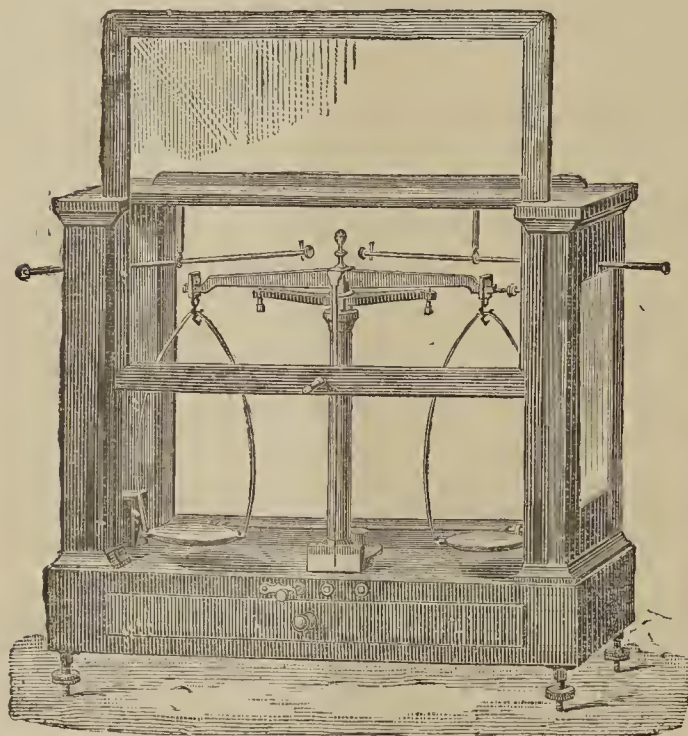
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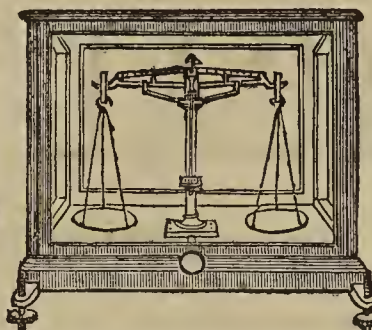
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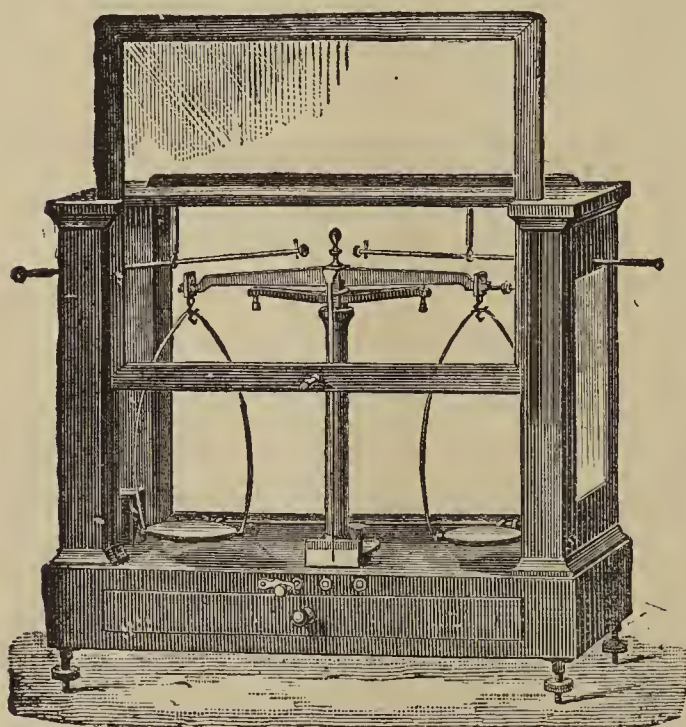
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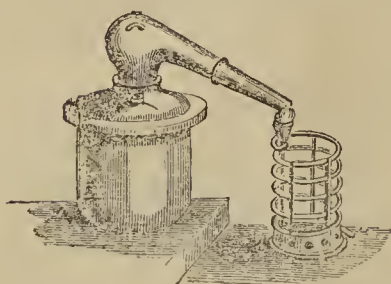
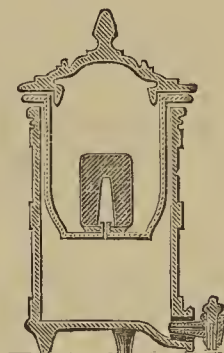
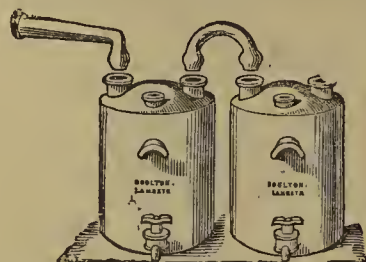
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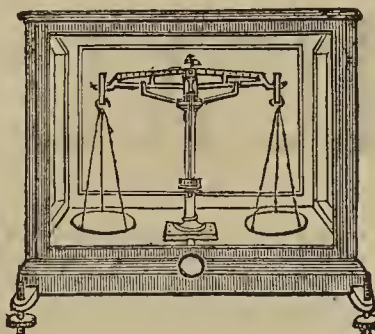
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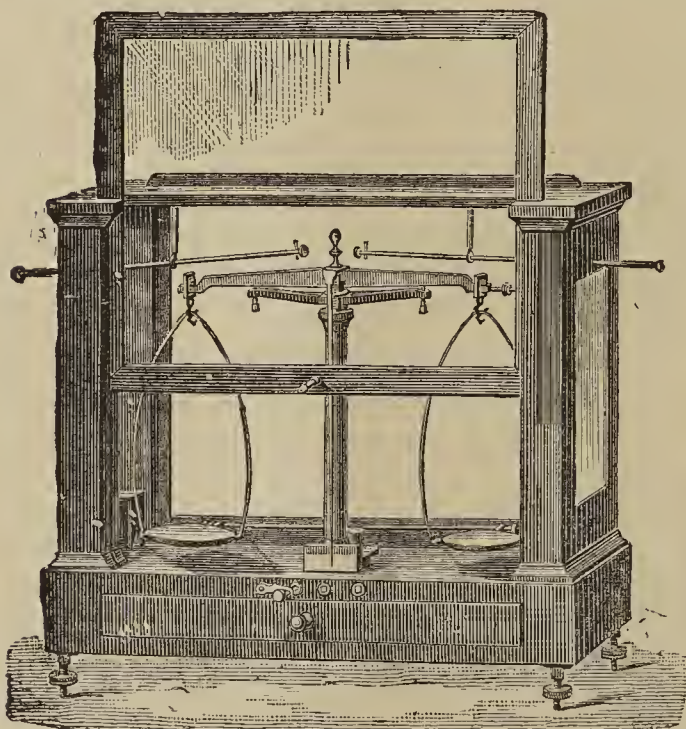
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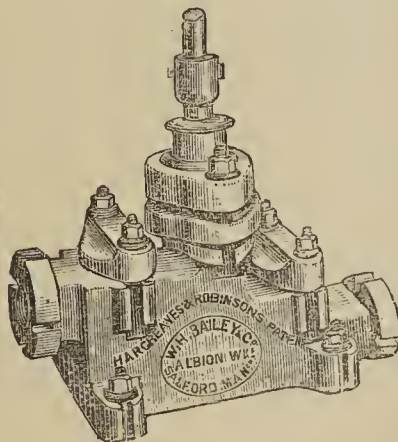
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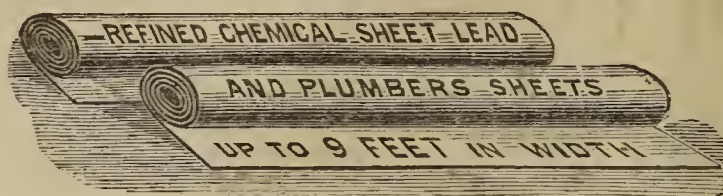
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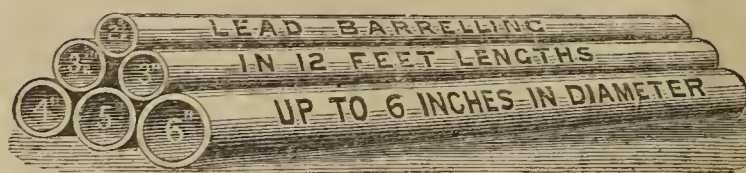
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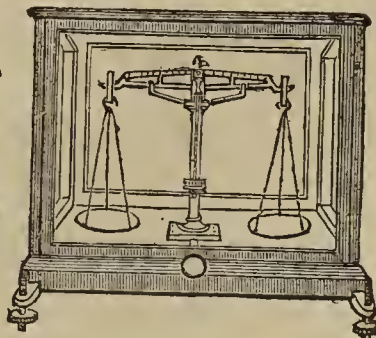
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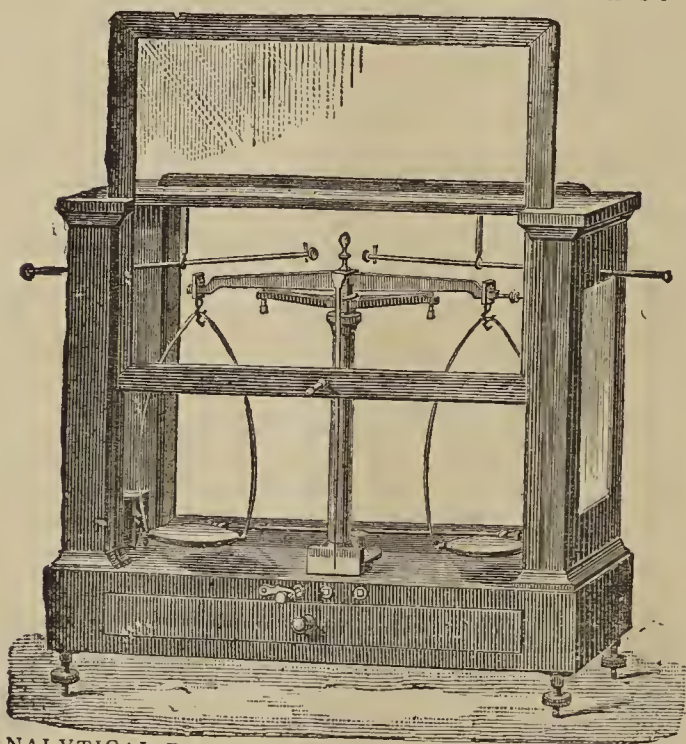
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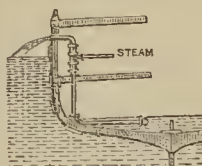
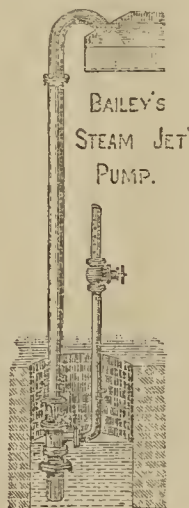
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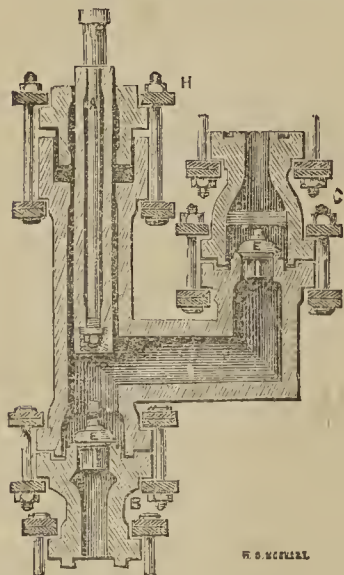
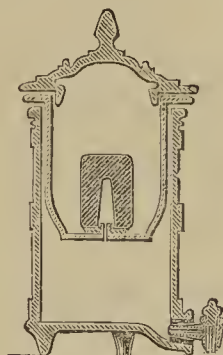
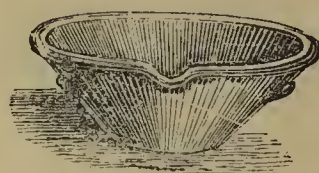
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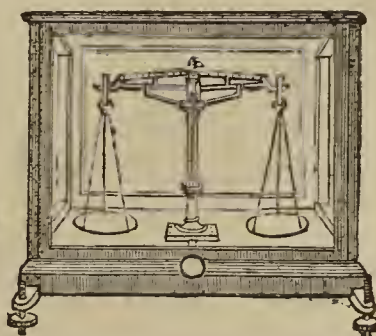
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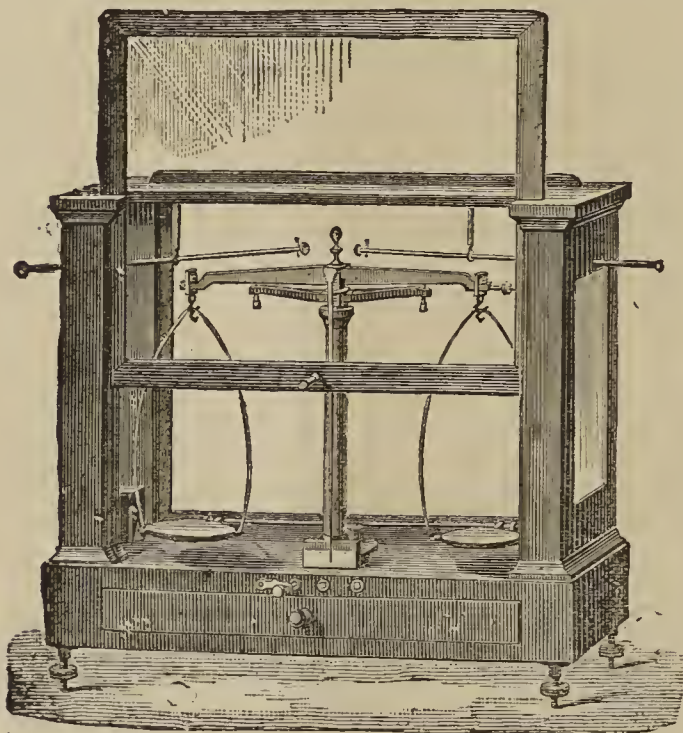
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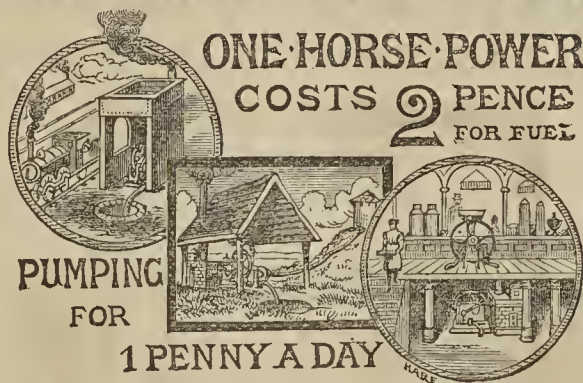
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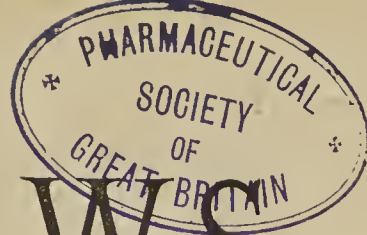
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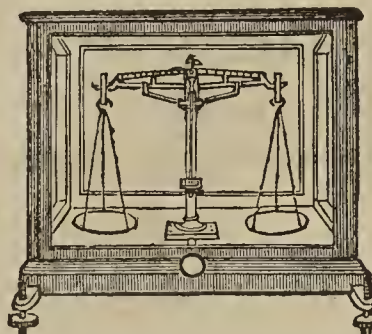
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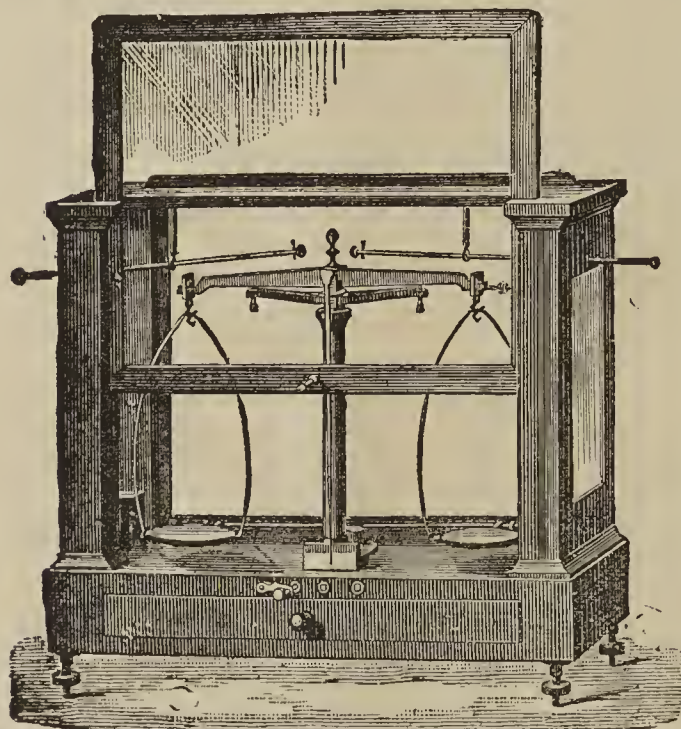
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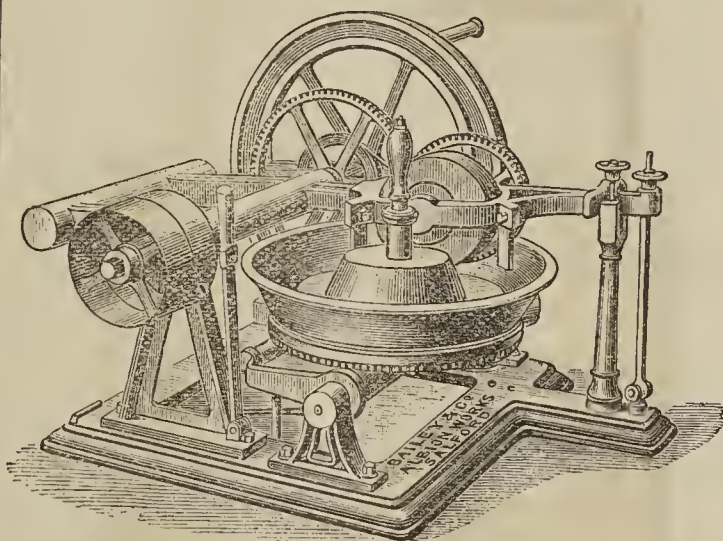
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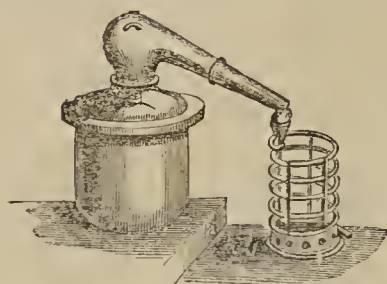
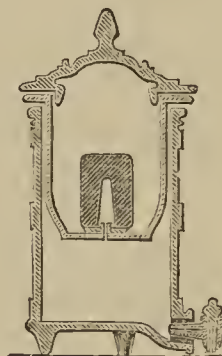
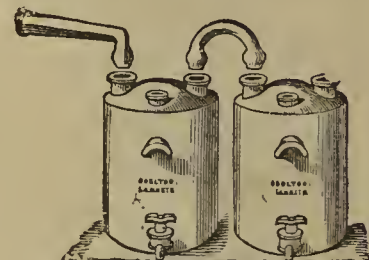
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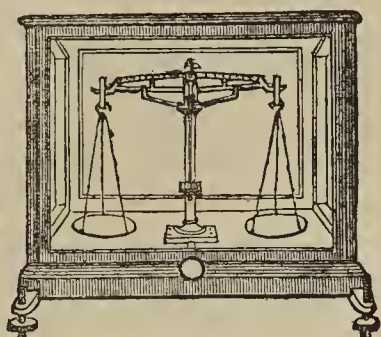
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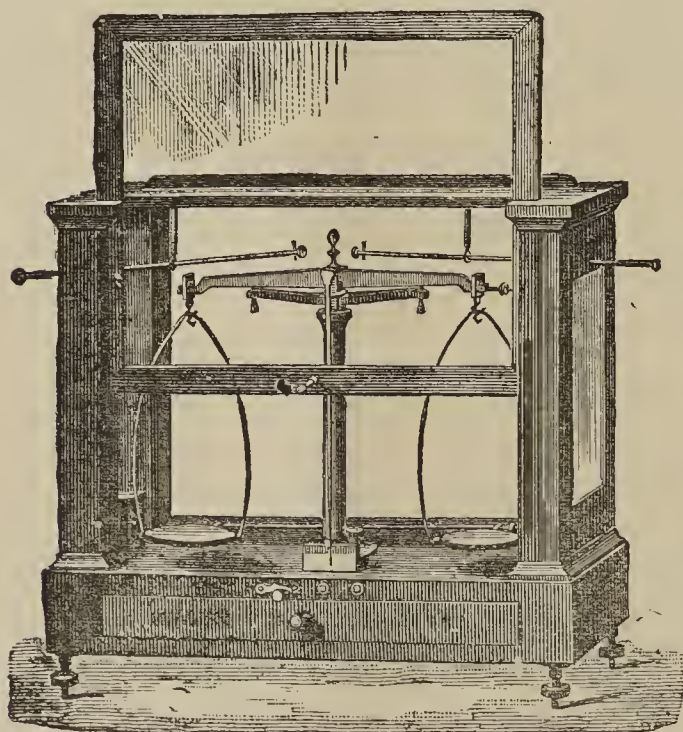
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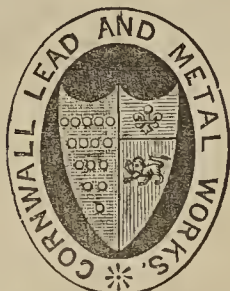
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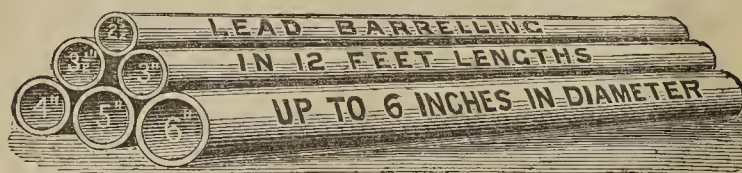
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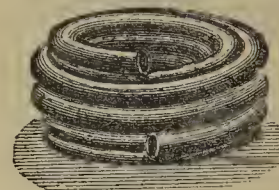


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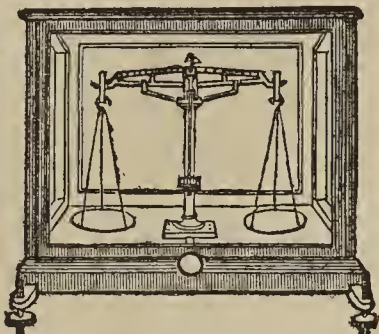
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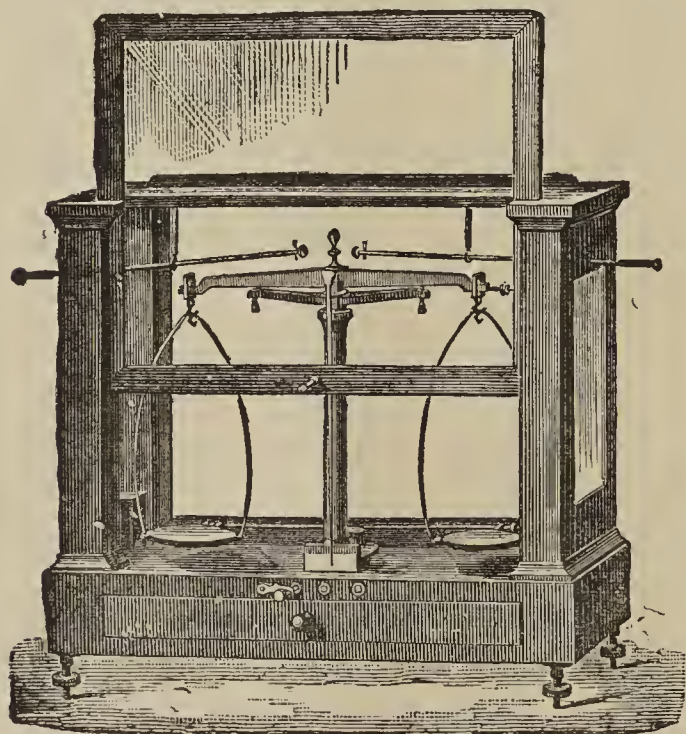
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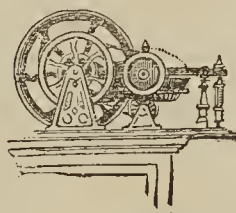
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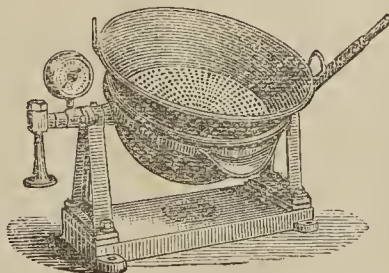
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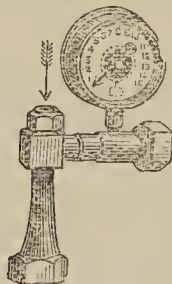


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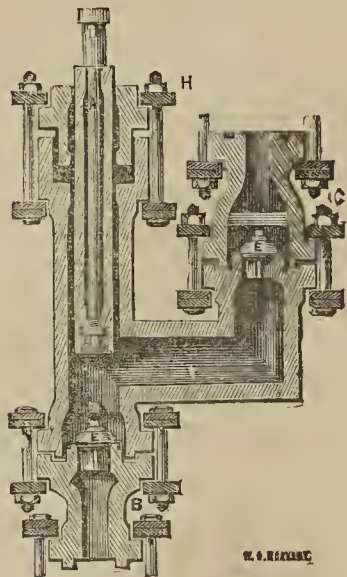
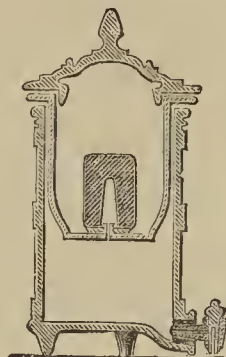
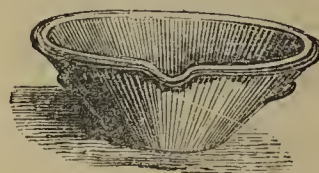
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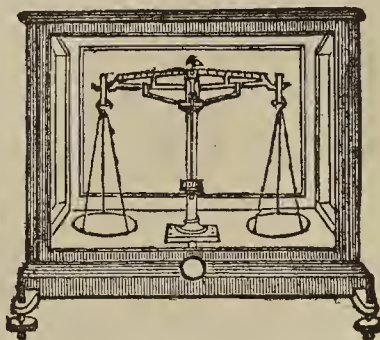
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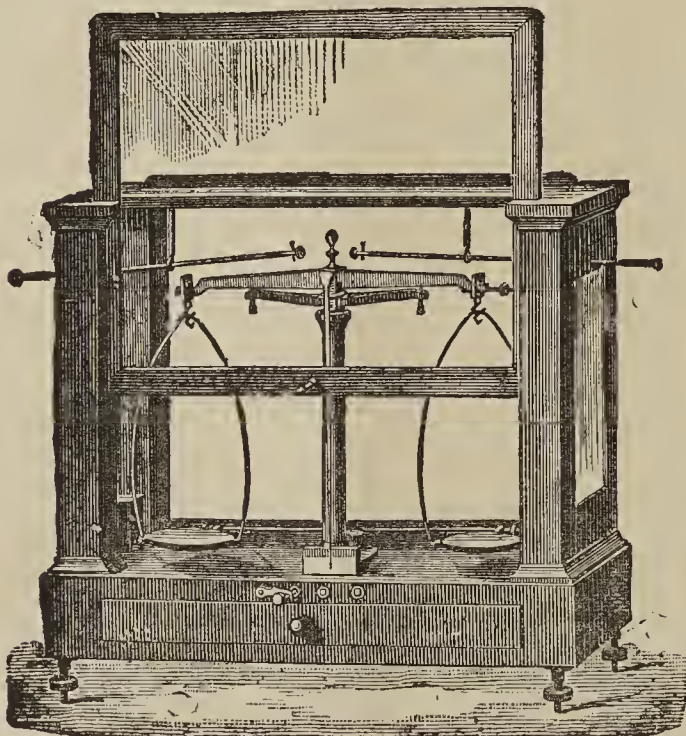
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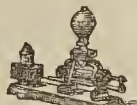
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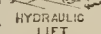
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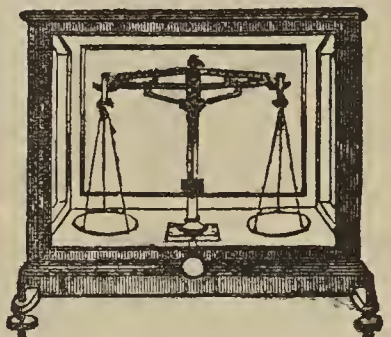
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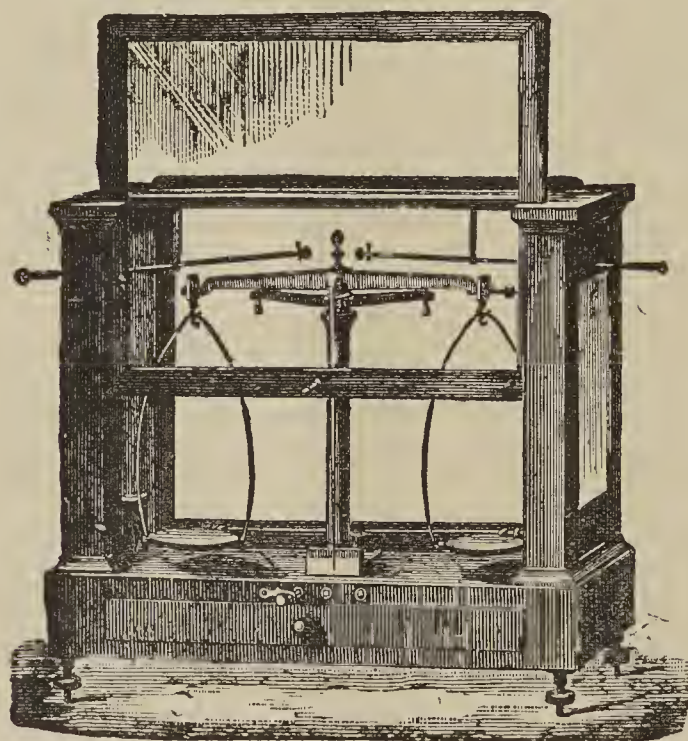
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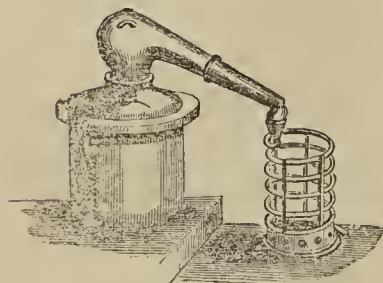
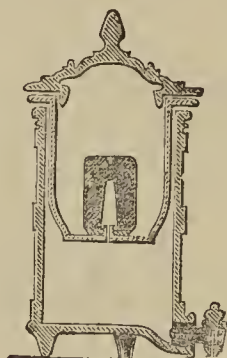
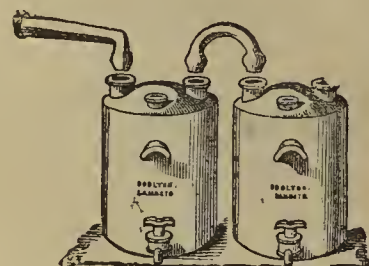
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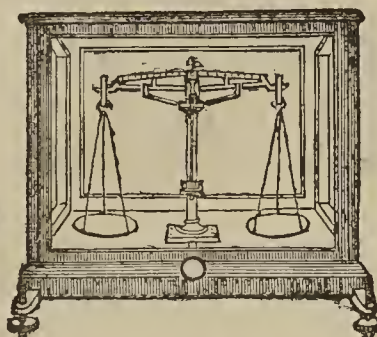
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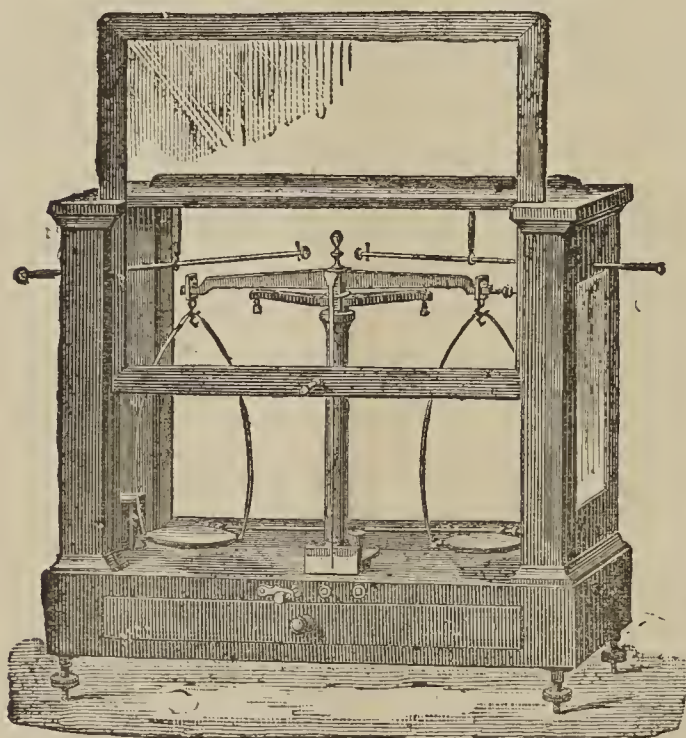
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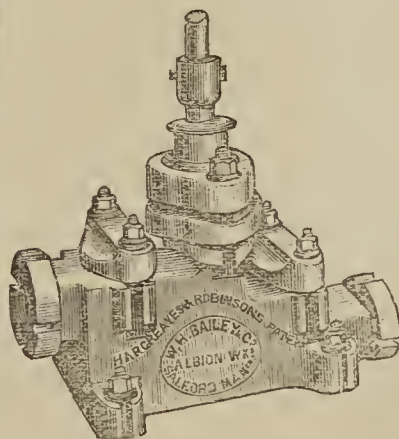
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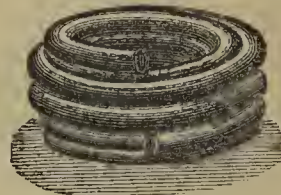


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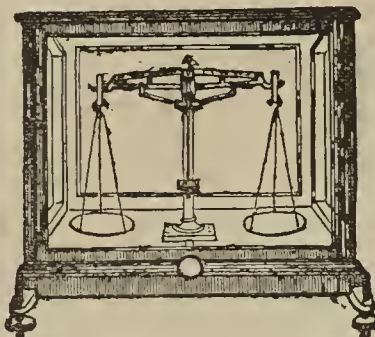
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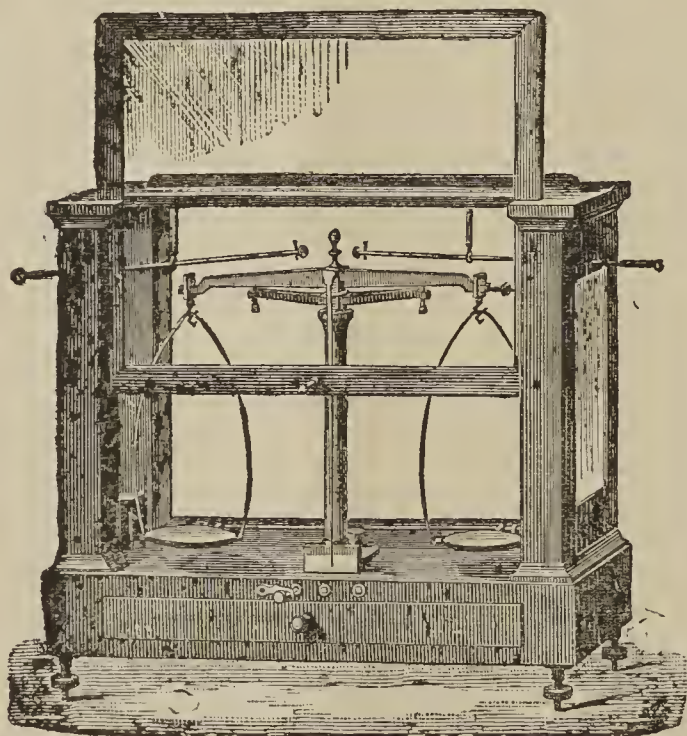
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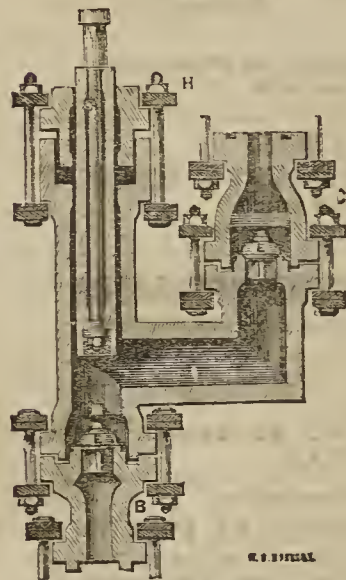
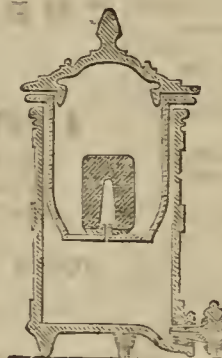
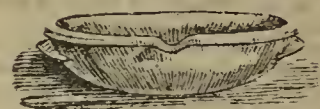
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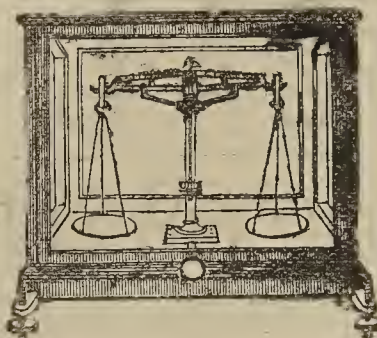
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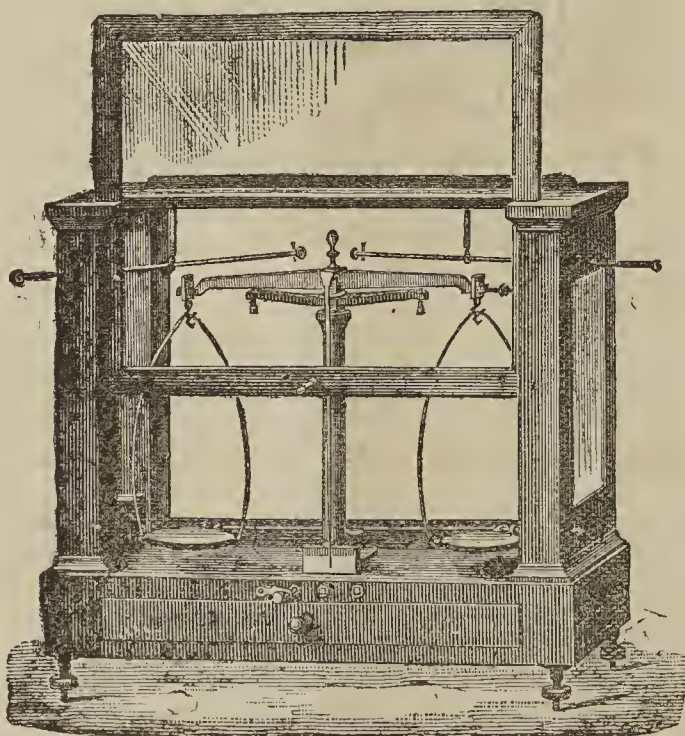
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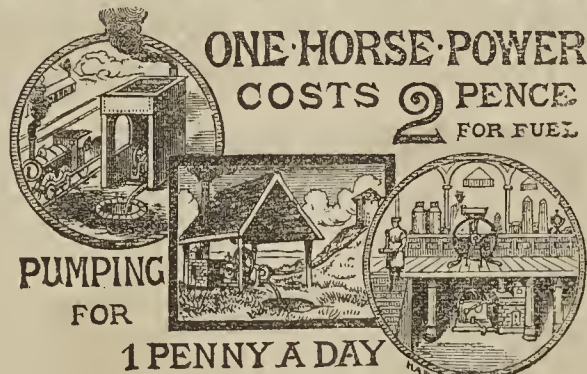
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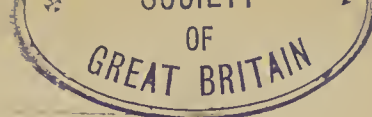
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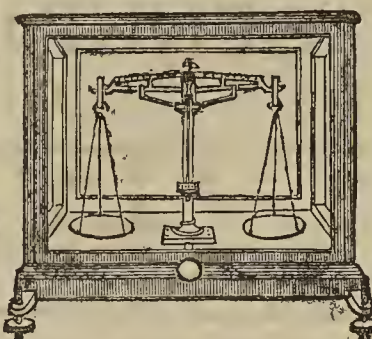
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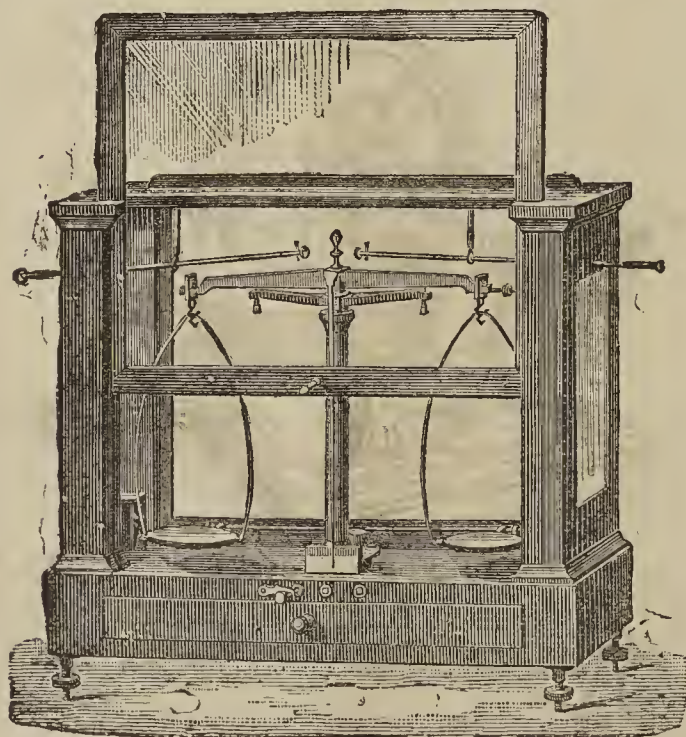
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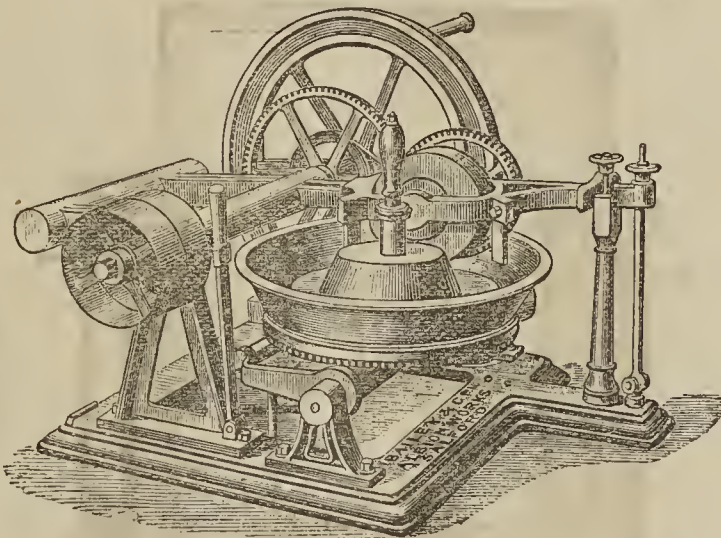
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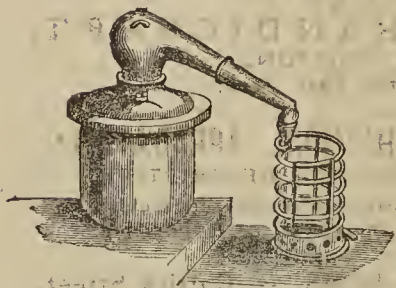
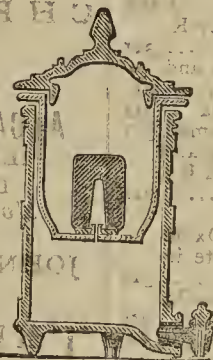
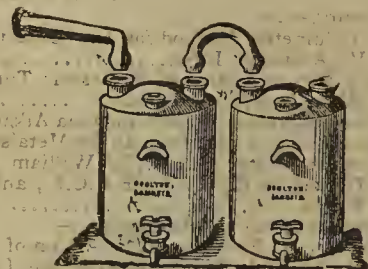
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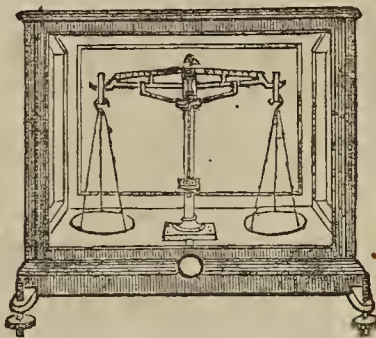
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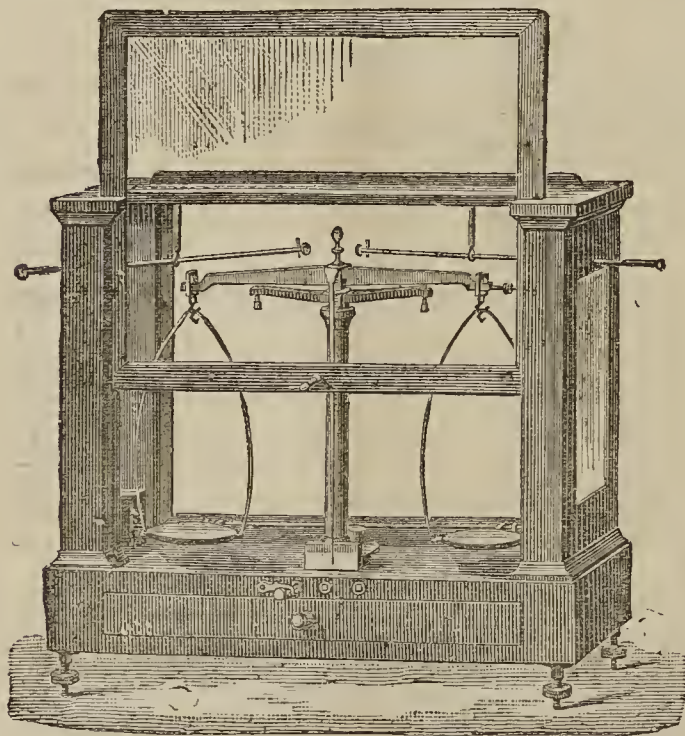
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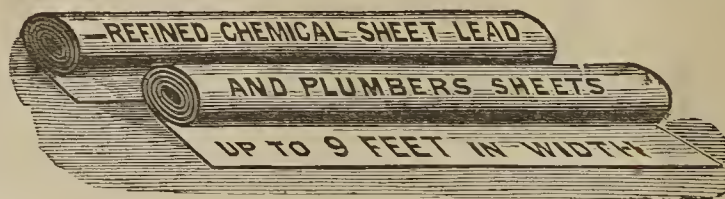
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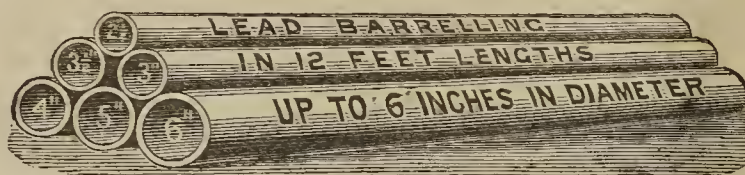
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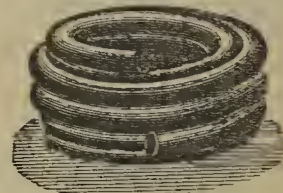


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THE CHEMICAL NEWS.

VOLUME LII.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

No. 1336.—JULY 3, 1885.

SILVER IODIDE AS A BLOWPIPE REAGENT.

By P. CASAMAJOR.

IN the CHEMICAL NEWS of February 20th, 1885 (vol. li., p. 88), is a paper, by Messrs. Wheeler and Ludeking on reactions of various metals, obtained by heating their compounds with tincture of iodine. Coatings of various colours are deposited on the support, which in many cases are striking and characteristic. The support used by these investigators is a thin plate of plaster of Paris, on the white surface of which the colours of the deposits are brilliantly displayed. The compound to be examined is placed on this plate, near the edge; alcoholic tincture of iodine is poured over it, then the blowpipe flame touches it for a very short time, giving rise to the coatings, which deposit on the plate, beyond the point touched by the flame.

I have repeated the experiments of Messrs. Wheeler and Ludeking on lead, mercury, tin, bismuth, and molybdenum. The results were eminently satisfactory. As tincture of iodine may be found at any country apothecary's, it is interesting to know that it may be used to obtain characteristic reactions with the blowpipe in case of need.

These experiments of Messrs. Wheeler and Ludeking suggested the idea of using silver iodide to obtain the same results. This reagent was found on trial to give the iodide coatings very beautifully and quickly. Silver iodide has the advantage over tincture of iodine that it is a dry powder, easily kept in bottles which need not close very perfectly.

The iodide coatings of mercury, bismuth, and lead are familiar to all chemists who use a blowpipe. They are obtained by V. Kobel's mixture of equal parts of sulphur and of potassium iodide. Silver iodide has over this mixture the advantage that there is no sulphur to give deposits when operations are carried on in glass tubes, and no fumes of sulphur dioxide. It requires less time to obtain the coatings, and they have a more distinct appearance.

In experimenting with silver iodide, mixed with various metallic compounds, I have deposited the iodide coatings in open glass tubes of about 4 inches in length and $\frac{1}{4}$ inch in diameter. The substance to be tested is mixed into a paste with the silver iodide. A small portion of this mixture is placed at one end of the open tube and the blowpipe flame is blown on it for a short time. The iodide coatings immediately appear and are seen through the glass. The glass tube may be held by a tongs or

simply by a piece of paper, as the blowing is not sufficiently prolonged to heat the glass tube beyond what paper will stand.

A small quantity of powdered charcoal or lamp-black mixed with silver iodide and the substance to be tested, gives the characteristic coatings more quickly and distinctly.

The following metals have given iodide coatings in glass tubes:—

Mercury.—In tubes, as on other supports, the yellow and red iodides are produced simultaneously, and streaks of bright red are seen on a yellow ground.

Bismuth.—Yellowish red near the end of the tube, and thick brown coating beyond.

Lead and Tin.—Both these metals give bright yellow deposits which retain their colour when cold. These deposits cannot be distinguished one from the other, both being equally bright. In the case of tin a very strong smell of iodine is given off, which is possibly due to stannic iodide.

Arsenic.—Near the end of the tube to which the flame is applied, there is a yellow deposit; beyond this a white coating of arsenious acid. The yellow portion turns white on cooling, but becomes yellow again when the tube is heated over a flame.

Antimony.—The orange-red coating given by this metal becomes quite faint on cooling, but the colour becomes bright again when the tube is heated.

Zinc.—The deposit is white both when cold and when hot. The fumes are not very abundant; much less so than those due to lead or tin.

Iron makes a deposit which may be considered as characteristic, from the fact that the yellow coating in the tube is streaked with distinct dashes of brown. The yellow portion becomes white on cooling, but the brown streaks do not change.

Thallium.—A yellow coating is deposited, as with most metals. After this has taken place, if a reducing flame touches the deposit, this fades, leaving a grey tinge with an edge of purple. This seems to be characteristic of thallium.

Cæsium, Rubidium, and Lithium have not given deposits which can be called characteristic. The deposit from cæsium differs from those of the other two metals in being less volatile. The cæsium deposit does not extend far beyond the heated end of the tube. By increasing the heat it melts, but does not move forward.

Chromium gives a white coating which remains at the

hot end of the tube. The portion nearest to this end, by further heating, becomes of a pale reddish brown.

Manganese.—Yellow hot, but white when cold, like deposits from many other metals.

Molybdenum.—Beyond the yellow coating, which turns white on cooling, are distinct blue streaks, which are very characteristic. I believe these were first observed by Messrs. Wheeler and Ludeking by treatment with tincture of iodine, on tablets of plaster of Paris. I was not able with these tablets to get anything but a narrow fringe of blue around the yellow coating (white, cold). With a glass tube, the blue streaks extend through the whole length of the tube.

Manganese and Uranium give deposits which are yellow when hot and white when cold. These are too common to be characteristic.

I have obtained deposits on charcoal and on thin sheets of iron, either on the metallic surface or on a coat of soot, by the use of silver iodide and metallic compounds. Some of these deposits are very good, but they are not so uniform for the same metal as deposits obtained in glass tubes.

CRYSTALLINE BASIC CUPRIC SULPHATES.

By SPENCER PICKERING, M.A.

As Shenstone, in a paper on "A Crystalline Tricupric Sulphate" (*Chem. Soc. J. Proc.*, 1885, 375), refers to my work on these basic salts, I may, perhaps, be excused for pointing out a small error which he has committed. He states that "up to the present all" of these salts (apparently two only of them being definite compounds) "except bronchontite, native tetracupric sulphate, have been described as amorphous powders." The tricupric salt, as obtained by myself, was invariably an amorphous powder, and so also was the tetracupric salt containing four molecules of water, as obtained by the decomposition of copper sulphate by potassium hydrate or copper hydrate. The dihydrated tetracupric salt, however, obtained by the decomposition of copper sulphate by an acetate, though amorphous at first soon becomes granular, and on some occasions distinctly crystalline; the crystals are very minute, and have a silky, glittering appearance, very much resembling those of lead iodide when separated out by cooling a hot aqueous solution of that salt. This fact was duly mentioned in my communication on the copper salts (*CHEMICAL NEWS*, vol. xlvii., p. 182).

The tricupric salt obtained by myself under conditions similar to those which yielded Shenstone his specimen, but at lower temperatures, contained a larger quantity of water, and this would indicate a higher molecular weight than that which he adopts; the two hydrates being $2\text{CuSO}_4 \cdot 4\text{CuO} \cdot 5\text{H}_2\text{O}$ and $2\text{CuSO}_4 \cdot 4\text{CuO} \cdot 4\text{H}_2\text{O}$ respectively.

Influence of the Moisture of the Soil upon the Production of Plants.—Prof. Hellriegel.—If a soil becomes so far desiccated as not to convey moisture to plants so rapidly as it is lost by evaporation, the energy of the movement of the sap within the plant and the tension of the organs is reduced. When this process has continued for some time the elasticity of the cell walls sinks so far that it becomes outwardly manifest by the relaxation of the parts of the plant. Fading indicates not the beginning of the affection, but the commencement of the last stage. External fading does not begin until the plant has lost nearly half its moisture. Different plants do not behave quite alike with different degrees of moisture in the soil, but the differences are not very important. The production of plants is much reduced, even by short periods of drought, and a subsequent abundant supply of water does not remove the injurious effects of a previous deficiency.—*Biedermann's Centralblatt*, Part 2.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,

Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from vol. li., p. 304).

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
|| Following a date signifies publication discontinued.

77. **COMPTES-RENDUS MENSUELS DES TRAVAUX CHIMIQUES** de l'étranger, ainsi que les laboratoires de Bordeaux et de Montpellier, rédigés, avec la collaboration de A. Laurent, par Charles Gerhardt. 7 vols., 8vo. Montpellier, 1845-'51.

The paper cover also bears the title: *Annuaire de chimie*.

CRELL, LORENZ VON. See *Auswahl aller eigenthümlichen Abhandlungen*; also, *Auswahl vorzüglicher Abhandlungen*; also, *Chemische Annalen für die Freunde der Naturlehre*; also, *Chemisches Archiv*; also, *Chemisches Journal*.

78. **CRELL'S CHEMICAL JOURNAL**. Giving an account of the latest discoveries in chemistry, with extracts from various foreign transactions; translated from the German, with occasional additions. 3 vols., 8vo. London, 1791-'93.

An English edition of *Chemische Annalen für die Freunde der Naturlehre*. q. v.

CROOKES, WM.

See *Chemical Gazette* [b].

DENZER'S *GEWERBERLATT*.

See *Technisch-chemisches Gewerbeblatt*.

DETMER, W.

See *Jahresbericht der Agricultur-Chemie*.

79. **DEUTSCHER CHEMIKER-KALENDER**. Jahrbuch und Notizbuch für den theoretischen und practischen Chemiker, Fabrikanten, Bierbrauer, Branntweinbrenner, Zuckerfabrikanten. Herausgegeben von Paul Bennewitz. [Later, von H. von Gehren.] 3 vols., 16mo. Dresden, 1875-'77.]

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80. **EDINBURGH (THE) JOURNAL OF SCIENCE**. Exhibiting a view of the progress of discovery in natural philosophy, chemistry, mineralogy, geology, botany, zoölogy, comparative anatomy, practical mechanics, geography, navigation, statistics, antiquities, and the fine and useful arts. Conducted by David Brewster; with the assistance of John MacCulloch for geology, chemistry, etc.; W. Jackson Hooker for botany; John Fleming for natural history; Will. Haidinger for mineralogy; Robt. Knox for zoölogy and comparative anatomy; Sam. Hibbert for antiquities and geology. 10 vols., 8vo. Edinburgh, 1824-'29.

Second series. 6 vols., 8vo. Edinburgh, 1829-'32.

United in 1832 with the "*Philosophical Magazine, or Annals*," [etc.], forming the "*London and Edinburgh Philosophical Magazine*." See *Philosophical Magazine*.

ELSNER, L. (AND F.).

See *Chemisch-technischen Mittheilungen*.

ELWERT, J. C.

See *Magazin für Apotheker, Chemisten*, [etc.].

ENTDECKUNGEN (DIE NEUESTEN) IN DER CHEMIE.

See *Chemisches Journal*.

ERDMANN, OTTO L.

See *Allgemeines Journal der Chemie* [d.].

ERDMANN'S JOURNAL.

See *Journal für technische und ökonomische Chemie*.

ERLENMEYER, E.

See *Kritische Zeitschrift für Chemie*.

FÉRUSSAC, BARON DE.

See *Bulletin des sciences mathématiques... et chimiques*.

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

REDUCTION OF METALLIC SOLUTIONS BY MEANS OF GASES, &c.*

By G. GORE, LL.D., F.R.S.

THE following experiments were made chiefly for the purpose of ascertaining the effect of various gases and liquids in reducing metals from their solutions:—

Experiment 1.—A mixture of dry and pure carbonic oxide and carbonic anhydride gases, passed in a stream slowly through various liquids, had the following effects:—A solution of bichloride of palladium was rapidly decolourised and all its metal precipitated as a black powder. One of tetrachloride of platinum was slowly decomposed, and yielded a small amount of yellow precipitate in two or three days. With one of chloride of iridium and potassium, the whole of the iridium was precipitated after a long time. Solutions of argentic nitrate, mercuric chloride, plumbic nitrate, ferric chloride, manganoous chloride, permanganate of potassium, chromic acid, and a green solution of vanadium showed no signs of reduction. A solution of green vitriol with which an excess of pure sodic hydrate had been mixed did not become oxidised.

Experiment 2.—The same mixture of gases was passed through a lead vessel containing milk of lime. It imparted to the surface of the vessel a film of red oxide of lead, probably by reduction of carbonate of lead by the carbonic oxide.

Experiment 3.—By passing carbonic oxide during two days through a solution of potassic cyanide with a rod of bright magnesium half immersed in it, the liquid became brown; and the metal was coated with a blackish film in the liquid. Magnesium alone, in a similar solution, did not turn the liquid brown in three days.

Experiment 4.—A dilute solution of bichloride of palladium, exposed to a mixture of hydrogen and carbonic anhydride (or to pure hydrogen alone), had the whole of its palladium gradually precipitated in the metallic state in a period of twenty-four hours.

Experiment 5.—An atmosphere of coal-gas was maintained in contact with the following dilute liquids, each of which had a vertical platinum wire partly immersed in it. The liquids were in open bottles in a dark place. Dilute solution of palladic chloride; rapid reduction to the state of metal as a film upon the surface of the liquid in four hours; the solution became colourless in a few days; some of the metal was also precipitated as a black powder, and some as an adhering bulky lump on the end of the wire. With dilute terchloride of gold, in the course of a few days beautiful films of metal, bright and of exceeding thinness, were produced upon the surface of the solution. Much gold was also deposited upon the bottom end of the wire. The films formed successively and sank. The liquid was not wholly decomposed in three weeks. (Solid crystals of auric chloride were gradually reduced to metal). Solution of platinic chloride was only slightly decomposed in ten weeks. With a solution of argentic nitrate, signs of decomposition occurred in a few hours. In fourteen days a deposit of metal had formed upon the sides of the glass bottle; but the whole of the silver was not deposited in seven weeks. With cupric sulphate no reduction and but little action upon a strip of copper (instead of platinum) took place in ten weeks. With a platinum wire in a dilute solution of ferric sulphate, no visible effect occurred in eighteen days.

Experiment 6.—The gaseous products (containing acetylene) of a blown-down and smoky flame of a Bunsen's burner were collected over water and passed through various liquids. They rapidly decomposed solution of palladic chloride, and less quickly one of terchloride of gold; a solution of platinic chloride was slightly affected,

and one of chloride of iridium and potassium remained unaltered.

Experiment 7.—A solution of palladic chloride, in contact with amylene, showed signs of decomposition even in a few minutes, and was abundantly decomposed in two days; it was also reduced to metal by American petroleum, benzine, and Persian naphtha less speedily; slowly by toluol, xylol, "petroleum ether," and mesitylene; with the ether a bright metallic layer was formed between the two liquids. It was reduced very slowly by Rangoon lamp oil, and by "Sherwoodole;" and not at all by ozokerite, solid paraffin, or naphthaline.

Experiment 8.—An aqueous solution of auric chloride, especially a strong one, was rapidly decomposed by carbolic acid, with liberation of the metal; also, but more slowly, by mineral naphtha, Persian rock oil, benzole, C_2Cl_2 , and Rangoon "machinery oil," with similar effects; slowly by "petroleum ether;" and very slowly by toluol, xylol, and mesitylene. Paraffin, anthracene, naphthaline, C_2Cl_4 , Rangoon petroleum butter, C_2Cl_3 , benzoic acid, soft elaterite, hard elaterite, CCl_4 , "Sherwoodole," chrysene, or ozokerite, had but little or no decomposing effect. The solution of chloride of gold was less rapidly decomposed than one of palladic chloride, especially by mineral naphtha and benzole. Amylene produced a most beautiful film of gold upon the surface of the auric solution. Crystals of chloride of gold were partly reduced to metal in Persian naphtha in two days.

Experiment 9.—Platinum was separated from solutions of platinic chloride by benzole, American rock oil, Persian naphtha, and other similar liquids.

Experiment 10.—An aqueous solution of chloride of iridium and potassium was decolourised in two days by contact with benzole. With amylene no effect was visible in that time.

Experiment 11.—Amylene, in contact with an aqueous solution of mercuric chloride during one week, slowly produced a white precipitate. By agitating amylene with a solution of permanganate of potassium, the latter was instantly decolourised; the residue was entirely soluble in hydrochloric acid, but with one of cupric chloride in aqueous ammonia, or of ferric chloride, chromic acid, chromate, or acid chromate of potassium, no visible effect occurred.

Experiment 12.—Benzole, agitated with a solution of potassic permanganate, rapidly decolourised it, but had no effect upon one of perchloride of iron. Benzole darkened the colour of solutions of palladium, gold, and platinum.

Experiment 13.—With a solution of telluric chloride, or one of terchloride of antimony, amylene, benzole, and Persian naphtha produced only a slight effect in fourteen days. With Persian naphtha and a solution of chloride of bismuth a slight change occurred in eleven days.

The beautiful films of gold and palladium formed upon the surface of a liquid by a contact of a gas, or between two liquids at their dividing line, by a non-miscible solution, might prove of service in some physical experiments.

It is worthy of consideration by geologists whether the reduction of metals to the native state in the interior of the earth may not in some cases have been effected by contact of their solutions with liquid or gaseous hydrocarbons derived from coal and other mineral substances of organic origin.

Chemicals at the Antwerp Exhibition.—Dr. Theodor Schuchardt, of Görlitz, has favoured us with a catalogue of the chemical preparations he exhibits at the Antwerp "Weltausstellung" during the present year. Judging from this list visitors of a chemical turn of mind will see many very interesting compounds both organic and inorganic. Amongst the rare substances exhibited we note metallic erbium, yttrium, gallium, tantalum, and niobium, as well as many of their salts. The exhibit of organic compounds is a very large and unique one.

* From the *Proceedings of the Birmingham Philosophical Society*, Vol. iv., Part I.

ON A NEW KIND OF METALLIC SPECTRA.

By M. LECOQ DE BOISBAUDRAN.

At the meeting of the *Académie des Sciences* on June 8th, 1885, M. Lecoq de Boisbaudran requested that a sealed packet which he had deposited June 30th, 1884, might be opened. The packet was opened by the Permanent Secretary during the meeting, and contained the following note:—

"When the electric spectrum of a solution *with a metallic base* is produced it is customary to make the outside platinum wire (whence the induction spark strikes) positive, the liquid consequently forming the negative pole.* If the direction of the current is reversed the metallic rays (due to the free metal or to one of its compounds) are scarcely or not at all visible, at all events so long as the exterior platinum wire now forming the negative pole is not coated with a deposit.

"Having again taken up last year my researches on the rare earths belonging to the didymium and yttrium family, I had occasion to observe with many of my preparations the formation of spectrum bands, nebulous, but sometimes tolerably brilliant, having their origin in a thin layer of a beautiful green colour, which was seen to appear at the surface of the liquid (a solution of a chloride) when it was rendered *positive*.

"These are the approximate positions of the principal bands:—(See Table next column.)

"On comparing in the different products the relative intensities of this new reversion spectrum and of the already known direct rays, I have come to the conclusion that the body producing the band α 115½ is very probably *not* one of the following:—

"Didymium, erbium, Y_a (of M. de Marignac), lanthanum, samarium, zirconium, scandium, thulium, ytterbium, yttrium.

"Cerium and thorium are also excluded for chemical reasons.

"I have not yet obtained the new spectrum with a substance altogether free from holmium, but I have good reasons to think that this metal is not the cause of the observed phenomena.

"The treatment undergone by the earths which give most sharply the reversion spectrum hardly admits in my preparations of the presence of such bodies as phosphoric, boric, &c., acids.

"The band α 115½ (and most of the others which, except perhaps the band $104\frac{1}{10}$, follow in their intensities the same variations as α 115½) appears, therefore, only to be attributable to terbia, unless, indeed, it be due to some new analogous earth not hitherto defined.†

"The treatment of a yellow earth obtained from samarskite, and much resembling that which is now called *terbia*, has already given me interesting results, which, however, it will be difficult to describe in this short preliminary note. I will only say that all the bands specified above (except sometimes $104\frac{1}{10}$) are especially very marked in the earth which is most easily precipitated by ammonia, which has a sulphate least soluble in potassic sulphate, and whose chloride, very soluble in pure water, is difficultly soluble in concentrated hydrochloric acid.

"Shall we find two earths respectively characterised by the bands $104\frac{1}{10}$ and α 115½?

"The production of my reversion spectrum appears to be analogous physically with the formation of the phosphorescence spectra obtained by Mr. Crookes at the positive pole in his high vacuum tubes containing certain compounds of yttria. The conditions of the two experiments are, however, very different practically speaking.

* This rule, hitherto 'general for *metallic*' solutions is not always applicable to liquids containing *metalloid* bodies, as I have already had occasion to notify (see *my Spectres Lumineux*, p. 38).

† There remains to be examined the earth decipia (of M. Delafontaine), the existence of which appears to be confirmed by the researches of M. Clève.

Micrometer.		λ .	Observations.
91½	About the middle.	620½	A narrow band, somewhat hazy. Rather faint. About 1½ divisions wide. (Due to calcium? ?)
101	Approximately about the middle.	585½	A nebulous band slightly connected with the following one. About 3 divisions wide. Slight intensity, but generally stronger than 91½.
104½	Approximately about the middle.	573	A nebulous band. Intensity varying with the state of the liquid and strength of spark. It seems to be fainter in the earths obtained from the sulphates which are very slightly soluble in potassic sulphate than in the earths obtained from the more soluble double sulphates. In some cases it has been seen as brilliant as α 115½, but it has almost always been seen <i>much</i> more feeble than 115½ in the earth obtained from the very slightly soluble double sulphate. It has, indeed, on several occasions been seen fainter than 101.
From 111½ to 112	About the beginning. Very indistinct.		A nebulous band, shading off from right to left. Rather strong, and generally much the most brilliant in the spectrum of the yellow earth whose double potassic sulphate is very slightly soluble.
115½	About the middle of maximum of light.	543½	
117	About the end. Very indistinct.		
About 141½	Apparent centre.	487	A very hazy band, appear-somewhat shaded from right to left when the spectrum is brilliant. About 4 or 4½ divisions wide. Somewhat joined to the following. Generally of very moderate intensity.
About 147½ to 147½	Apparent centre.	476½	Faint band, very hazy. About 6 divisions wide.

"It is a singular fact that the positions of the phosphorescence bands observed by Mr. Crookes with very pure compounds of yttrium, are sufficiently near those which I, on my part, have obtained with hydrochloric solutions of the earths separated as widely as possible from yttria, chemically as well as spectroscopically. My reversion spectrum cannot, I think, be attributed to yttrium, for on the one hand it is seen *brilliantly* with products which give no trace of yttrium rays by the direct spark, and on the other hand I have found it impossible to obtain it sharply from certain earths extremely rich in yttria.

"As soon as my work is sufficiently advanced to enable me to arrive at some definite conclusion, I shall have the honour of informing the Academy of it."

M. Lecoq de Boisbaudran added the following additional note:—

I have not yet finished the very long work undertaken

in the hope of determining the nature of the above described phosphorescence spectrum.

This spectrum is now recognised as being identical with that which is ascribed to pure yttria by Mr. Crookes, and which this *savant* obtained under experimental conditions very different to mine. Nevertheless, my latest observations, as well as the older ones, lead to the conclusion that yttria is not the cause of the spectrum bands observed. In my fractionations the phosphorescence spectrum regularly gets weaker as I advance towards the yttria end. With almost pure yttria the phosphorescence bands show themselves faintly or not at all, whilst they are brilliant with the earths which do not give, by the direct spark, the rays of yttrium to an appreciable extent.

The prodigious sensibility of Mr. Crookes's reaction, which detects a millionth part of his purified yttria, makes very singular this divergence which I am obliged to point out between the conclusions of the eminent English chemist and myself. Mr. Crookes has willingly undertaken to examine some of my products in his high vacuum tubes; and, on the other hand, he has promised to send me the earths prepared by himself so that I can examine them by my process. A comparison of these cross experiments, it is hoped, will throw some light on the question of the origin of the phosphorescence spectrum.

Another conclusion from my researches, a conclusion which I publish with a certain reserve because my work is not yet finished, is that the bands 105 and 115 do not belong to the same element. On this hypothesis, based on the fact that some of my products give 105 notably stronger than 115, whilst others show 115 brightly and 105 faintly. I will provisionally call *Za* the earth characterised by 105, and *Zβ* the earth giving 115.

Space does not allow me to describe to-day the principal experiments or observations undertaken to find out what are *Za* and *Zβ*; this will form the subject of another memoir.

I should acknowledge here that Mr. Crookes was the first to see the phosphorescence spectrum of samarium. During the past year only this spectrum was pointed out to me by my learned friend M. Demarçay, to whom I had confided the secret of my method for the production of phosphorescence spectra by the reversion of the induced current. I then made a drawing of it.—*Comptes Rendus*, vol. c., p. 1437, June 8, 1885.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 18th, 1885.

Dr. H. MÜLLER, F.R.S., President, in the Chair.

(Concluded from vol. li., p. 309.)

52. "On the Influence of Silicon upon the Properties of Cast Iron." By THOMAS TURNER, Assoc. R.S.M.

The author has prepared "pure cast-iron," that is, cast-iron as free as possible from the ordinary impurities, by heating wrought-iron with charcoal for about five hours. The composition of the product was C = 1.98, Si = 0.19, Mn = 0.14, P = 0.32, S = 0.35. The cast-iron was then melted with suitable quantities of silicon pig-iron containing C = 1.81, Si = 9.80, Mn = 1.95, P = 0.21, S = 0.04, and from the product test-bars of about 1.1" diameter and 19.7" long were prepared.

These bars, tested by Professor Kennedy with the University College testing machine, gave the following results:—(See Table next column).

These results show that, contrary to the generally accepted views on this subject, a suitable addition of silicon to cast-iron improves the tensile strength of the metal.

Silicon, per cent.	Breaking Load. Tons per square inch.	Modulus of Elasticity.
0	10.14	25.79 millions.
0.5	12.31	28.67 "
1	12.72	31.18 "
2	15.70	23.56 "
2.5	14.62	25.45 "
3	12.23	21.15 "
4	11.28	15.64 "
5	10.16	18.72 "
7.5	5.34	14.75 "
10	4.75	13.93 "

Any further addition, however, beyond 2.5 per cent causes a gradually increasing deterioration.

Each test-piece was analysed after fracture, and the results of these analyses are given. They show that the actual silicon and carbon content is always very near to that desired, while the sulphur and phosphorus are fairly constant. The manganese increases gradually up to 1.95 per cent.

It is shown that the graphitic carbon is increased by the addition of silicon, and consequently the iron passes in character from white to grey. The addition of silicon renders the metal more fluid, and gives smoother, finer castings; and, in moderate quantity, undoubtedly renders the metal more sound. In larger quantities, however, it renders the metal brittle.

DISCUSSION.

Mr. SPILLER said a Blue-book was published about 1860, by Sir Frederick Abel, containing an account of similar experiments with cast-iron. He had taken part in those experiments. The results arrived at were very different from those now put forward: in fact, he was inclined to question altogether Mr. Turner's conclusions, as he was not satisfied with the method of testing adopted, particularly the shape and size of the testing bars.

Dr. WRIGHT emphasised the fact that the figures adduced showed the carbon to be in a very different condition though the same in amount in the different specimens tested; he did not think that the specimens were comparable.

Mr. TURNER, in reply, said that unfortunately he was not acquainted with the Blue-book referred to, and that it was not mentioned in the metallurgical books. [Mr. SPILLER, interposing, said the results were quoted in *Watts's Dictionary*.] He had acted under the advice of engineers in preparing the test bars. It was true the carbon was in a different condition, but the difference was due to the silicon.

53. "Eleven Months' Experience with Toughened Glass Beakers." By R. J. FRISWELL.

In July, 1884, twenty-one beakers were purchased of the Toughened Glass Company, working De la Bastie's patents. One of these was broken by an accident and twenty were taken into use in the laboratory of the Atlas Works. They had the form of thin tumblers furnished with a lip. The bottom is about three times as thick as the sides, and weight for weight they are 2½ times as heavy as the Bohemian beaker of about the same capacity.

It was stated on behalf of the makers that they would stand boiling over the flame of a rose burner while supported on wire gauze, but as one of them burst soon after he began to use them, on pouring hot water into it, the more severe treatment was never tried, and they were relegated to ordinary use.

Of late they have been considerably in use in collecting some somewhat tarry distillates, and since then have begun to show evidences of rapid decay. Some slight signs of this had been noticed early in the career of some of them, but as it principally took the form of slight surface corrosion and dulling of the glass, it was attributed to the well-known action of caustic alkaline solutions.

The new action was different, the sides exhibiting a mass of exceedingly minute fissures, so close together and

running so completely over the surface of the beaker that it had the appearance of being covered with a tissue of spider's web. The next change consisted in the surface of the glass completely exfoliating, so that on rubbing the finger along the surface, a mass of minute plates could be detached. At length one of the beakers was attacked in this way over about one-third of its surface, and the boundary between the attacked part and that simply fissured was a sharp line passing up both sides and across the bottom. He at first thought that this indicated imperfect annealing or tempering, and, in fact, showed the depth of immersion in the oil-bath.

On a little consideration this appeared highly improbable, and he accordingly, though with little hope of solving the mystery, resolved to try whether the two liquids used to clean the glasses when very dirty had anything to do with it.

A beaker was half filled with caustic soda solution, another with strong sulphuric acid 1·845, and another with 25 per cent sulphuric acid.

At the end of 72 hours neither the caustic soda nor the weak sulphuric acid had produced any effect, but the beaker with the strong H_2SO_4 was entirely ruined by an extensive exfoliation which left plates sticking up from the surface from $\frac{1}{4}$ m.m. to $\frac{1}{2}$ m.m. in height.

The beaker in which the 25 per cent acid had been washed and placed on its side to dry on a piece of thick grey filtering paper lying on top of a copper water-oven. In about one hour's time a broad strip up the side in contact with the paper had exfoliated both inside and outside. It was moistened with water, turned over and replaced. In about half an hour another strip of exfoliation had begun.

Near the edge of the vessel the scales took the form of hairs 1—2 m.m. long, and completely curved over at the upper end in the form of the letter C.

About ten days back one of the slightly fissured beakers burst spontaneously, and a few days after another followed suit, both containing water at the time.

The thick bottom of one of these was a reticulated mass of cracks; when obliquely illuminated each crack shows as a slight depression of the surface.

The result of eleven months' use may thus be summarised:

Of 20 beakers—

2 burst spontaneously.. .. .	= 10 per cent.
1 burst on hot water being poured in	5 "
6 useless from fissures and enfoliation	30 "
8 are in good condition	40 "
3 have been broken by unknown means	15 "
—	—
20	100

Taking into consideration the loss of confidence caused by the high percentage of spontaneous bursting, it may be said that toughened glass is a complete failure in the laboratory.

The following papers were taken as read:—

54. "Bromo-derivatives of Diphenyl, Tolyphenyl, and Ditolyl." By Prof. CARNELLEY and ANDREW THOMSON.

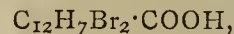
Tribromodiphenyl, $C_6H_4Br \cdot C_6H_3Br_2$ (1:4—1?), prepared by the action of excess of bromine on diphenyl dissolved in 1:4 tolyphenyl, crystallises in colourless silky needles (m. p. 90°), and is very difficultly soluble even in hot alcohol. On oxidation it yields 1:4 bromobenzoic acid (m. p. 248°).

The authors have obtained two modifications of *dipara-dibromodiphenyl* by the action of bromine on pure diphenyl. They both melt at 162° , and are in all respects identical, except that the one crystallises in prisms and the other in octohedral. The latter does not appear to have been previously observed.

Monobromo-(1—4) tolyphenyl, $C_{13}H_{11}Br$, obtained by brominating the pure hydrocarbon, crystallises in small pearly plates (m. p. 131°), and is almost insoluble in cold,

and only difficultly soluble in hot alcohol, but very easily soluble in benzene.

Two isomeric modifications of *dibromo-(1—4) tolyphenyl*, $C_{12}H_7Br_2 \cdot CH_3$, were obtained by the action of bromine on the 1—4 hydrocarbon, but it was not found possible to separate them. On oxidation of the mixture two isomeric modifications of dibromophenylbenzoic acid—



were obtained. The one melted at 202° and the other at 232° .

Monobromo-(2—4') ditolyl, $C_6H_4Me \cdot C_6H_3BrMe$ (Br?), was prepared by the action of bromine on the hydrocarbon. It crystallises in fine interlacing microscopic needles (m. p. 94°). It is only very slightly soluble in cold alcohol, and difficultly soluble in hot, but easily soluble in ether or benzene. On oxidation it yields monobromoterephthalic acid (m. p. 306°).

Monobromo-(2—4') ditolyl, $C_6H_4Me \cdot C_6H_3BrMe$ (Br=4), an oil which, on oxidation, gives *monobromodiphenic acid*, $C_6H_4(COOH) \cdot C_6H_3Br \cdot COOH$, melting at 215° , and this, on further oxidation, is converted into 4:2:1 *monobromophthalic acid*, $C_6H_3Br(COOH)_2$ melting at 203° .

Dibromo-(—4') ditolyl, $C_{14}H_{12}Br_2$, was obtained by the action of the calculated quantity of bromine on the hydrocarbon. It crystallises in beautiful long, almost hair-fine, lustrous needles (m. p. 156°). This dibromo-compound behaves in a remarkable manner on oxidation, giving first a brilliant yellow compound (m. p. 170°) having the composition of a diketone, $C_{12}H_6Br_2(CO)_2$, isomeric with dibromophenanthraquinone, but having a different orientation. On further oxidation the dibromoditolyl gives a brilliant yellow product, very similar to the diketone just described, but melting at 201° , and having the composition of a dibromodiphenic acid, $C_{12}H_6Br_2(COOH)_2$, but not really having the latter constitution, as it does not seem to possess the properties of an acid.

55. "Note on the Influence of Strain upon Chemical Action." By Prof. CARNELLEY and JAMES SCHLERSCHMANN.

The experiments were undertaken with the object of determining whether strain had any influence upon chemical action. It appeared *a priori*, not impossible that there might be an effect such as would increase chemical action, for presumably any condition which would tend to lessen the attractive force between the particles of an iron wire, for example, would also assist the action of acids, &c., on such a wire. Two series of experiments were made as follows:—

Series A.—In such experiment copper wire (18 gauge) was exposed for three hours to the action of 100 c.c. of a 10 per cent solution of ammonium chloride. In one set of experiments the wire was kept stretched by a weight of 2 lbs., and in a second set by a weight of 28 lbs. The copper dissolved by the liquid was determined colorimetrically with potassium ferrocyanide.

The results were as under:—

	Strain on Wire = 2 lbs.	Strain on Wire = 28 lbs.
Expt. (1). Copper dissolved	= 5·5 m.grms.	5·5 m.grms.
" (2). " "	= 5·1 " "	5·1 " "
" (3). " "	= 5·2 " "	5·2 " "

Series B.—In each experiment iron wire (19 gauge) was exposed for three hours to the action of dilute sulphuric acid (1:25). In one set of experiments the wire was kept stretched by a weight of 2 lbs., and in a second set by 56 lbs. The iron dissolved was determined colorimetrically by potassium ferrocyanide. Results as under:—

	Strain on Wire = 2 lbs.	Strain on Wire = 56 lbs.
Expt. (4). Iron dissolved	= 2·0 m.grms.	1·8 m.grms.
" (5). " "	= 2·0 " "	2·0 " "
" (6). " "	= 2·0 " "	2·0 " "

These experiments show, therefore, that strain exerts

no perceptible influence upon chemical action, or, at least, not under the conditions above described.

56. "*On the Non-existence of Gaseous Nitrous Anhydride.*" By WILLIAM RAMSAY, Ph.D.

In replying to Dr. Lunge's criticisms on a recent paper by Mr. Cundall and himself, the author points out that Dr. Lunge's proofs of the existence of gaseous nitrous anhydride all involve the presence of sulphuric acid; and moreover that the behaviour of Dr. Lunge's nitrous anhydride, acknowledged by him to be a body at least capable of partial dissociation, is unique, inasmuch as the extent of its dissociation is not increased by rise of temperature. The author then describes experiments which prove that on mixing gaseous nitric peroxide with nitric oxide, no diminution of volume is observable; as reaction between these gases would imply contraction, it is concluded that no reaction takes place, so long as they are gaseous. But on cooling the mixture of gases a deep blue liquid is condensed, which is doubtless a mixture of liquid nitrous anhydride with liquid nitric peroxide; it is thus seen that on assuming the liquid state reaction is possible.

57. "*On the Causes of the Decrepitations in Samples of so-called Explosive Pyrites.*" By B. BLOUNT.

Having obtained certain samples of pyrites showing in a marked manner the phenomenon of decrepitation when heated to moderate temperatures, the author of the paper examined these samples to determine, if possible, whether the decrepitations were produced—(1) By the expansive force of water contained in the cavities of the ore, or (2) the expansive force of gas similarly contained. Weighed quantities of the pyrites were heated in a Liebig's tube to 100° C., and the gas or vapour evolved collected in weighed absorption-tubes. From these experiments it was found that moisture and carbon dioxide were given off in the decrepitation of the pyrites. The amounts of water and CO₂ given off were not in the proportions corresponding to the formula H₂CO₃, the CO₂ being much in excess of the moisture. The cavities are apparently very widely and not at all regularly, distributed throughout the samples. The author concludes (1), that the decrepitations are due to the presence of CO₂, together with greater or less quantities of moisture; (2), that the CO₂ is confined at high pressures, probably sufficient to liquefy it; (3), that the usual temperature at which the pyrites begins to decrepitate is 30°—35° C.

58. "*On the Specific Action of a Mixture of Sulphuric and Nitric Acids upon Zinc in the Production of Hydroxyamine.*" By E. DIVERS, M.D., F.R.S., and T. SHIMIDZU, M.E.

No quantitative experiments appear to have been published upon the variable activity of zinc towards sulphuric acid. Carefully cleaned sheet-zinc of one quality may show the greatest differences in the rate at which it dissolves in sulphuric acid of a certain dilution. In five minutes, four times as much zinc has been found to dissolve, from equal surfaces, in one experiment as in another. In this case, 15 per cent sulphuric acid was used. With weaker acid the difference would sometimes prove much greater, as when in 20 minutes' immersion in 3 per cent acid, the dissolved metal was 10 times greater in one case than in another, under conditions arranged alike. But these differences diminish as the duration of the dissolution is prolonged. In 20 minutes the greatest difference observed with 15 per cent acid has been but little more than four to three.

Zinc that proved tolerably sensitive to sulphuric acid from the first showed a solubility in the acid of different strengths that was approximately in proportion to the dilution of the acid; but zinc, nearly inactive in 3 per cent acid, dissolved in 15 per cent acid, in fifteen minutes, twelve times as much as it did in 7½ per cent acid. These differences in activity towards sulphuric acid are shown also by granulated zinc, but not to the same extent. They do not seem to be due merely, or even to a great extent, to differences in composition of commercial zinc,

but to be galvanic phenomena. Nitric acid is also irregular in its action upon zinc, but much less so than sulphuric acid.

The action of a mixture of nitric and sulphuric acids is very much more rapid than that of either of these acids, of similar dilution, by itself. Thus, dilute nitric acid mixed with three times its volume of a dilute sulphuric acid, of less average activity upon zinc than itself, formed a mixture at least five times as active as the dilute nitric acid by itself was. The experiments were so arranged that there should be no material rise in the temperature, as that would of itself have greatly increased this disproportion.

Both the nascent hydrogen hypothesis, and that of the sulphuric acid serving to keep unreduced nitric acid free, entirely fail to explain such a superior activity in the mixed acids; and the only view of the matter that appears sufficient for the purpose is that the mixed acids exert a specific action upon the zinc, by virtue of which the sulphuric acid is decomposed by the combined action upon it of the nitric acid and the zinc. Alone these bodies are inactive, or nearly so, upon it, but together they at once decompose it, just as hydrochloric acid and selenium together decompose sulphuric acid, or as nitric oxide and stannous chloride together decompose hydrochloric acid.

Hydroxyamine, in acid solution, is not decomposed by zinc, as it has hitherto been assumed to be. Its solution may even be boiled upon zinc for some time, provided it is kept acid, without undergoing appreciable change. As a consequence of this fact, the hydroxyamine formed by zinc in a mixture of nitric and sulphuric acids remains in the solution for some minutes unaffected, and only declines in quantity as the sulphuric acid approaches neutralisation. Even in absence of acid, hydroxyamine in solution is only slowly decomposed by contact with zinc, so long as the solution is cold. In hot solutions it is much more rapidly changed.

The production of ammonia from nitric acid by zinc in presence of sulphuric acid must be regarded as the result of the direct and independent action of the nitric acid upon the zinc. It seems also nearly certain that hydroxyamine is the sole product of the specific action of the mixed acids, and that it would not be producible by zinc alone from truly pure nitric acid.

Variations in the proportions of hydroxyamine obtained from nitric acid by treating it with sulphuric acid and zinc depend very largely upon undetermined peculiarities in the zinc. One zinc may prove three times as productive as another. This difference in productiveness does not appear to depend altogether upon differences in the activity of the zinc towards sulphuric acid, or upon differences in composition. Lead seems to be indifferent, while iron sometimes acts injuriously.

The production of hydroxyamine is favoured by heat, nearly boiling solutions giving somewhat better yields than cold ones provided that the sulphuric acid is not too much diluted, and that it is in sufficient excess over the nitric acid; increase in its amount is without effect upon the yield of hydroxyamine. The degree of dilution of the nitric acid has no apparent effect upon the yield of hydroxyamine. An investigation of the effects of varying circumstances upon the yield of hydroxyamine from nitric acid by the action of zinc and sulphuric acid is greatly impeded by the irregular behaviour of what, in other respects, appears to be the same quality of the metal.

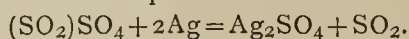
59. "*On the Action of Pyrosulphuric Acid upon certain Metals.*" By E. DIVERS, M.D., F.R.S., and T. SHIMIDZU, M.E.

New reasons for considering liquid or solid sulphur trioxide as [S₂O₆] rather than as [SO₃] are afforded by the results of some experiments upon the reaction of pyrosulphuric acid with silver, mercury, and copper.

When carefully freed from sulphuric acid and moisture sulphur trioxide is without action upon these metals; it is otherwise when a little sulphuric acid is present. Silver

dissolves freely in melted pyrosulphuric acid without evolution of gas. The products are silver sulphate and sulphur dioxide, which remains dissolved in the fuming acid, in which it is very soluble. Mercury behaves like silver, but, as its sulphate is less soluble in sulphuric acid, this soon begins to separate. Also, when the solution of the mercury is poured into water, there is obtained not sulphur dioxide, but metallic mercury, besides mercurous sulphate. The cause of this difference is merely that the sulphur dioxide reduces some of the mercurous sulphate when the two substances come in contact with the water.

The reaction between silver or mercury and the fuming acid is clearly one between it and sulphur trioxide, since the metal is practically unacted upon by cold sulphuric acid itself. The metal displaces the radical sulphuryl, which then becomes sulphur dioxide:—



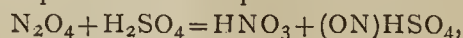
Pure sulphur trioxide cannot act upon these metals because of the insolubility of the sulphate in it.

The propriety of viewing the reaction as one between the sulphur trioxide and the metal is further shown by the behaviour of copper with pyrosulphuric acid. Copper is acted upon only until it gets coated with a mixture of sulphate and sulphide. Copper sulphate is almost insoluble in sulphuric acid. The sulphide results from reaction between sulphur dioxide and copper. Divers has already in a recent paper advanced the view that the action of hot sulphuric acid upon copper, mercury, and silver is in reality one between the metal and sulphur trioxide, into which and water sulphuric acid so readily dissociates at a moderate heat.

The treatment in the cold of mercury with pyrosulphuric acid is recommended for the preparation of mercurous sulphate.

60. "*On the Constitution and Reactions of Liquid Nitric Peroxide.*" By E. DIVERS, M.D., F.R.S., and T. SCHIMIDZU, M.E.

It is improbable that when hot gaseous nitric peroxide $[\text{NO}_2]$ condenses to the liquid peroxide, $[\text{N}_2\text{O}_4]$, the two nitrogen atoms directly unite, because the direct combination of two atoms of nitrogen in the simple body itself, or in compounds, is a very stable one. But evidence is still wanting that the peroxide is nitrosyl nitrate, $[\text{ON}\cdot\text{O}\cdot\text{NO}_2]$. The only reaction that points to this constitution is that between the peroxide and sulphuric acid—



in which it changes into nitrosyl sulphate and hydrogen nitrate. This want of evidence is greatly lessened by the knowledge of the reactions between nitric peroxide and some metals.

Mercury treated with dry rectified nitric peroxide is converted into mercurous nitrate, with more or less mercuric nitrate, nitric oxide being liberated. Silver is superficially converted into nitrate also with the evolution of nitrous oxide; and neither in the case of mercury nor of silver is nitrite formed. The reaction is, therefore, the displacement by metal of nitrosyl in its nitrate.

The reaction with copper appears to be the same, but its exact determination is rendered difficult by the instability, in contact with water, of cuprous nitrate, for that is the copper salt which appears to be formed. The product treated with water gives metallic copper and cupric nitrate, and with concentrated alkali, alkali nitrate, and cuprous hydroxide. But other changes occur, the cuprous hydroxide seeming to reduce some nitrate to ammonia, and cupric nitrate solution reacts with finely divided copper to form nitric oxide and basic copper nitrate.

The action of heat upon silver nitrate has been reinvestigated. The salt has been heated in absence of air. The results confirm those formerly got by Divers. Heated only to 125° , it slowly decomposes to silver nitrate, silver and nitric oxide. Heated strongly, it changes, to a large extent, into nitric peroxide and silver, although some silver nitrate and nitric oxide are formed. The fact,

formerly ascertained by Divers, that silver nitrite, heated cautiously in a confined space, can, by absorption of oxygen from the air, become nitrate without the formation of much free silver, is considered to indicate that the formation of nitrate is due to the action of nitric peroxide upon silver, and not to the oxidation of nitrite. It is regarded as unlikely that silver nitrite unites directly with free oxygen, and it is shown that nitric peroxide has no action on silver nitrite. If silver were not converted into the nitrate, it is inexplicable why, after 78 hours' exposure to a temperature decomposing silver nitrite, it should be possible to have only a small fraction of the silver in the metallic state.

61. "*On the Behaviour of Stannous Chloride towards Nitric Oxide, and towards Nitric Acid.*" By E. DIVERS, M.D., F.R.S., and T. HAGA.

In contradiction to statements and assumptions hitherto made, it is asserted that tin and hydrochloric acid do not convert any part of either nitric oxide or nitric acid into ammonia. Also, that stannous chloride does not form ammonia from these bodies—at least, not below or up to 100° . Thirdly, that hydroxyamine is not converted to ammonia, or otherwise affected, by either hydrochloric acid and tin, or hydrochloric acid and stannous chloride, whether in hot or in cold solution.

Ammonia is formed, however, when nitric oxide is treated with either tin or stannous chloride and acid, in presence of oxygen. To want of care in excluding air, and to indifference as to the purity of the nitric oxide employed, must be attributed the experience of previous workers that ammonia is formed from nitric oxide. For von Dumreicher's statements that hydroxyamine is rapidly converted into ammonia by acid stannous chloride at 100° , and that nitric acid yields ammonia when treated with that reagent, no explanation has suggested itself, by which they can be made consistent with the experiences here recorded.

Besides hydroxyamine, some nitrogen is produced by the action of stannous chloride upon nitric oxide. Strange to say, at 100° , stannous chloride is without any action upon nitric oxide, except the doubtful production of a trace of ammonia. At common temperatures, there is probably an unstable compound produced, such as— $[\text{Cl}_2\text{Sn}(\text{ON} : \text{SnCl}_2)_2]$, and this, decomposing with hydrochloric acid, yields stannic chloride and hydroxyammonium chloride. Stannous chloride is readily, though slowly, converted to stannic chloride by nitric oxide.

Nitric acid is only acted upon by stannous chloride in presence of strong hydrochloric acid solution, not in presence of dilute acid. Nitrosyl chloride would thus appear to be the source of the hydroxyamine, and not the nitric acid. The action of the nitrosyl chloride upon stannous chloride will be that of its two radicles. This action will be further examined, but it already seems to favour the view held by Divers, that the nitrogen of nitric acid is trivalent rather than quinquivalent.

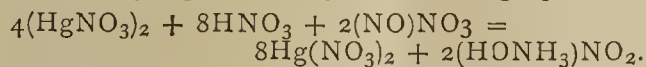
62. "*Preliminary Note on the Reaction between Mercurous Nitrate and Nitric Oxide, and between Mercurous Nitrate and Nitrites.*" By EDWARD DIVERS, M.D., F.R.S., and TAMEMASA HAGA.

It has been known for, perhaps, half a century, that mercurous nitrate yields metallic mercury when treated with a solution of alkali nitrite, and this reaction has been always regarded as one of oxidation of the nitrite by reduction of the mercury salt. Obviously true as this seems to be, we believe we can, even in this preliminary note, show that, nevertheless, it is not true.

When, with exclusion of air, pure nitric oxide is passed into a solution of mercurous nitrate in dilute nitric acid, a precipitation of metallic mercury slowly takes place, and hydroxyamine is formed in quantity, but no ammonia. The solution contains mercuric nitrate. By prolonging the contact of gas for many hours, beautiful long yellow prisms crystallise out, while the metallic mercury still

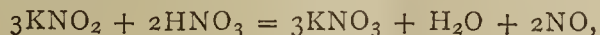
remains. The mother-liquor now contains a mercury salt of specific reactions, together with ammonia, but no longer any hydroxyamine. With hydrogen sulphide, it yields sulphur and a brown precipitate, which, when heated, effervesces and blackens. With potassium hydroxide, a precipitate, first reddish, then greyish, is obtained. The yellow crystals effervesce with acids, and are slowly changed by them. In this change, a little black matter is formed, and with hydrochloric acid both mercuric and mercurous chlorides are obtained. The black matter, heated again with fresh hydrochloric acid, yields metallic mercury. The gas evolved is pure nitric oxide. Neither ammonia nor hydroxyamine can be got from the crystals. Boiled with water they effervesce, and partly dissolve, and metallic mercury separates. Even cold water slowly separates mercury from them. Heated dry, they decompose much as do mercury nitrates. We hope to offer the Society a fuller account of this yellow salt in the early part of next year. We wish now only to comment specially upon the first stage of the reaction.

In the first stage of the reaction we have the remarkable phenomenon, not of nitric oxide acting as a reducing agent, for, on the contrary, much of it gets hydrogenised, but of *nitric oxide precipitating mercury from its salt*— $(\text{HgNO}_3)_2 + 2\text{NO} = 2(\text{NO})\text{NO}_3 + 2\text{Hg}$. We see no means of rejecting that equation, remarkable as it undoubtedly is. The nitrosyl nitrate, here assumed to form, will at once decompose with water and mercurous nitrate into hydroxyammonium nitrate and mercuric nitrate, perhaps in the way represented by the following equation:—



The after-reaction is probably one between mercuric nitrate and nitric oxide. The destruction of hydroxyamine presents no difficulty.

In the case of the long-known precipitation of mercury by a nitrite, we find that, provided the nitrite be added gradually to a concentrated solution of mercurous nitrate, kept in considerable excess, it is accompanied by an abundant production of hydroxyamine. The reaction can no longer, therefore, be treated as one of reduction of mercury salt by the oxidation of a nitrite. We are not yet prepared to speak with any certainty as to the exact nature of this reaction. The free acid of the mercury solution will probably yield alkali nitrate and nitric oxide—



and then the nitric oxide will react with the mercurous salt, as we have found it to do.

A hydrochloric acid solution of cuprous chloride is unaffected by nitric oxide.

63. "On some Derivatives of Anthraquinones." By A. G. PERKIN and Dr. W. H. PERKIN, jun.

The authors have studied the products of the destructive distillation of sodium anthraquinone sulphonate. By treating the crude distillate with boiling baryta-water they have separated metoxyanthraquinone. The residue contains anthraquinone, which can be extracted by glacial acetic acid, leaving a body of the formula $\text{C}_{28}\text{H}_{14}\text{O}_6$, which also dissolves, though very sparingly, in acetic acid, crystallising in minute yellowish-red needles. This compound yields anthracene when distilled with zinc-dust; it dissolves in cold sulphuric acid, forming an intense magenta-red coloured liquid; on oxidation with chromic acid it is converted into the compound $\text{C}_{14}\text{H}_6\text{O}_4$. This latter forms colourless plates melting at 292° ; it is insoluble in alkalis; it yields anthracene when distilled with zinc-dust, and it reacts with phenyl-hydrazine. The authors are inclined to regard it as an orthoquinone of anthraquinone.

The Kratakia Ashes of 1883.—Dr. A. Sauer.—The Kratakia ashes are derived from a lava belonging to the family of augite-andesite.—*Biedermann's Centralblatt*.

NOTICES OF BOOKS.

Commercial Organic Analysis: A Treatise on the Properties, Proximate Analytical Examination, and Modes of Assaying the Various Organic Chemicals and Products Employed in the Arts, Manufactures, Medicine, with Concise Methods for the Detection and Determination of their Impurities, Adulterations, and Products of Decomposition. By ALFRED H. ALLEN, F.C.S. Second Edition, revised and enlarged. Vol. I. London: J. and A. Churchill.

THIS edition of Mr. Allen's work has been re-arranged in a manner which will greatly add to its utility.

The first volume now before us includes bodies of the fatty series, the alcohols, ethers, sugars, starch, and vegetable acids. The second, shortly to appear, will discuss the coal-tar products and bodies of the aromatic series, hydrocarbons, and tannins. The third will deal with the cyanogen compounds, the organic bases, and the albumenoids.

The introduction contains much matter of great utility. The author distinguishes three kinds of chemical analysis: a separation of a substance into its constituents parts—in other words, a complete quantitative examination; an identification or recognition of some peculiar substance sought for; and a quantitative determination, more or less accurate, of the amount of some particular body, or of two or more important bodies. This kind of analysis is what is commonly termed assay.

The foreign bodies accidentally or purposely present are very naturally arranged by the author under a series of heads;—foreign bodies naturally accompanying the main substance and not readily removed; agents introduced during manufacture and imperfectly eliminated; foreign bodies added in small quantity for some legitimate object; foreign bodies generated by some spontaneous change; and lastly adulterants knowingly and wilfully added for the purpose of fraud.

In speaking of the methods for determining the specific gravity of liquids Mr. Allen makes a remark which has our entire approval. He writes:—"That such an instrument as Baumé's hydrometer should ever have come into general use is a serious misfortune; but that its indications should be different in England and America is discreditable to both countries." Unfortunately it is very widely employed in America.

The author also does well to point out that the value of elementary analysis for the chemical examination and assay of organic commercial products is comparatively limited.

The account of methylated spirit is in one respect left incomplete. It is said that "methylated finish is a preparation sold by those who are not licensed as vendors of methylated spirit." Now for the general public it is often no easy thing to buy anywhere methylated spirit free from shellac. Save for the varnish-maker and French polisher it would not be easy to devise a more objectionable addition. Nor does it answer the ostensible end of rendering the liquid undrinkable. We know as a matter of certainty that not merely ordinary methylated spirit, but even "finish" is consumed by workmen if they can get access to the store where it is kept.

Under ethylic alcohol we find mention of the unfortunate circumstance that several different strengths of so-called absolute alcohol are recognised in commerce.

We quite agree with the author in his condemnation of the term—or rather of the notion—"proof spirit." For all purposes it would be far simpler if the strengths of spirits were indicated by their percentage of absolute alcohol.

Under wines we find a very interesting note:—"However good in quality white sugar obtained from beet-root may be, on fermentation it always produces an alcoholic liquid having a disagreeable taste. Hence the white sugar

employed in the manufacture of champagne ought always to be derived from the sugar-cane." This is a part of the evidence going to show that beet-root sugar (betose), though agreeing in its percentage composition and in its behaviour with ordinary reagents with true saccharose, is in reality a distinct and inferior article.

"Plastering" wines is mentioned, but not condemned. We regret to find it stated that the use of absinthe is on the increase in London. We should decidedly recommend the absolute prohibition of its importation and manufacture or sale in this country. "Cape-smoke," which is, we suppose, identical with "cango," is mentioned as containing 0.24 of amylic alcohol to 100 of ethylic alcohol. Its proportion in the potato-whiskies of North Germany is not mentioned. It is to be regretted that this evil spirit is largely used in the manufacture of factitious wines.

There is a notice of the so-called artificial fruit-essences. That these bodies very closely simulate the odours and flavours of certain fruits must be admitted. Whether the resemblance extends to their physiological action is, to say the least, not proven. There is scope here for some useful investigations.

Under glucose we meet with an important remark:—"The United States Committee on glucose concluded that there was nothing of an injurious nature in the starch-sugar manufactured in America, which is derived entirely from maize, but their experiments did not extend to glucose from potatoes, with which the German chemists worked."

In speaking of trinitro-cellulose, Mr. Allen writes:—"It is dissolved by a mixture of ether, ammonia, and potash, and according to some by methyl or ethyl acetate (acetic ether), but this is most probably a mistake." Yet over the leaf, in giving directions for the assay of gun-cotton, he writes:—"Unaltered cellulose may be estimated by treating the gun-cotton left undissolved by the ether-alcohol (mixture of 3 parts ether and 1 of alcohol) with acetic ether, which dissolves the trinitro-cellulose and leaves the uncharged cotton." This, as we happen to know, is the method actually used by manufacturers of gun-cotton for detecting and estimating any cotton which has escaped conversion.

The starches are very elaborately discussed. There is a table of their microscopic characters, and the most important kinds are figured.

When speaking of the action of gums, as employed in thickening colours, we observe that Mr. Allen uses the word—un-English and unpronounceable save by German scholars—"fuchsine" instead of "magenta" as the common name of the salts of rosaniline.

Under formic acid we find the statement that "the stings of bees and wasps, as also of stinging nettles and hairy caterpillars, owe their irritating power to formic acid." The venom of the bee and the ant is unquestionably acid, but as Mr. Church has observed, and as we have verified, the poison of the wasp has a distinctly alkaline reaction.

We cannot conclude our notice of the first volume of this work without bearing testimony to the general accuracy to the contents and to the perseverance, patience, and judgment of the author in collecting and verifying the analytical methods given. To public analysts the work will be quite indispensable.

California State Mining Bureau. Fourth Annual Report of the State Minerologist, for the year ending May 15, 1884. By H. G. HANKS, State Minerologist. Sacramento: State Office.

THIS report contains a great quantity of matter of interest to the mineralogist and the metallurgist. Strong emphasis is laid on the wastefulness of the amalgamation process as at present carried on for the extraction of gold and silver. It is said that in all the cañons leading down from the Comstock mine the ground is "permeated with mercury which has been lost, not to say thrown away, in working the ores." By the present process, says the

writer, a large proportion of worthless matter, from 84 to 91 per cent of the ore, must be saturated with mercury to extract the silver from the small remaining portion. It has been proved that the metallic sulphides may be readily separated from the quartz by dint of its superior gravity, the concentrated portion only being the amalgamated. Thus an important economy in mercury would be effected. Quicksilver mining is not described as a very profitable business. The author, indeed, contends that there is need of further "protection" by a heavier duty being placed upon the imported article.

For determining the value of silver ores the author recommends the blowpipe assay, adding:—"The best work I know of is the 'Treatise on the Use of the Blowpipe,' by Plattner, translated by Muspratt." No one, we presume, will venture to question the superiority of Plattner's work. But we prefer the translation by T. Hugo Cooksley (Chatto and Windus) based upon the last German edition as revised by Prof. Richter.

Platinum occurs in California in considerable quantities, but unfortunately it has been neglected. The miners decline to save it when told that it can only be sold for two or three dollars per ounce.

Tellurium occurs in considerable quantity in altaite, calaverite, hessite, petzite, and tetradymite, and could probably be obtained at a relatively low figure if any application for it were discovered. The author remarks that it exists in a gaseous state, probably as hydrogen telluride, in the atmosphere of some of the fixed stars, especially in Aldebaran.

Roscoelite, an ore of vanadium, has been obtained to the extent of 400 to 500 lbs., all of which has been wasted in separating the gold associated with it, though not entering into its composition. According to the analysis of Prof. Sir H. E. Roscoe, here quoted, it contains 28.6 per cent of vanadium pentoxide. Prof. A. Genth criticises this analysis, maintaining that the sample examined by Sir H. Roscoe was not pure. This chemist also considers that "if any, only the smaller portion of the vanadium is pentoxide." It is probably that now vanadium has met with an important practical use in calico-printing it will be more carefully sought for.

Water-Works Statistics, 1885. Compiled from Special Returns received from Engineers and Secretaries throughout the United Kingdom. Edited by C. W. HASTINGS. London: Scientific Publishing Co., Limited.

THIS compilation undertakes to give items of information of varying importance. Opposite the name of the town we find stated the source of supply, the mode by which the water is conveyed, the quantity of water raised, assessment charge, meter charge, price per 1000 gallons, number of meters used, character of supply as constant or intermittent, and, where the works belong to a company, the dividend.

Some of these items, to persons interested in public health, are utterly worthless. We must therefore crave Mr. Hastings' permission to throw out a suggestion by which these "Statistics" could be made of immense sanitary value.

At present the relation of the death-rate to the quality of water consumed is an unsolved problem. But if in this work the waters were even roughly distinguished as "hard" and "soft," and if the mean death-rate were appended, we should have one important datum for the solution of the question. Space for this information might be gained by suppressing the useless column "gravitation or pumping." The column "gathering ground" might easily be made to convey more precise indication as to the quality of the water. At present the geological character of the gathering grounds, or of the formations into which the wells are sunk, is given in a few instances only. Judging from the preface, we see that the number of water-works which are the property of the municipal authority—

in other words, of the rate-payers—has increased from 88 to 118. This figure includes, we believe, all the important provincial towns in England, except Bristol and Sheffield. "Constant" supplies seem also to be taking the place of the intermittent system, with its necessary dirty cisterns, its ball-cocks and other appliances often out of order, and its greater facilities for waste and for freezing in the cold season. In 23 cases the dividends paid to shareholders reach, or exceed, 10 per cent, and in one, Basingstoke, even 20 per cent!

Gas Works Statistics, 1885. Compiled from Special Returns received from Engineers and Secretaries throughout the United Kingdom. Edited by C. W. HASTINGS. London: Scientific Publishing Company.

THE items here given are—Tons of coal carbonised; make of gas in thousands; sale of gas in thousands; illuminating power in thousands; price per 1000 cubic feet; number of consumers; price paid for public lamps; number of public lamps; sale price of coke; tons of sulphate of ammonia made, and dividend. Some of the results are highly instructive. The illuminative power of the gas ranges from 12 candle-power (Alderney, Theale, and Thrapston) to 30 (Berwick). The most surprising fact is that the Berwick works belong not to the municipal authority, but to a company. The average illuminating power of the gas furnished from municipal works is $17\frac{1}{2}$ candles.

The prices per 1000 cubic feet range from 1s. 10d. at Leeds and Sheffield, and 2s. at Birmingham, to 7s. 6d. at Bures and Lambourne, and 10s. at Lavenham and Kingsclere, which two towns modestly omit to give the illuminating power of their product. The prices obtained for coke are not comparable, being in some places given per ton, in others per chaldron, and in others per bushel.

The Gas and Water Companies' Directory for 1885. Edited by C. W. HASTINGS. London: Scientific Publishing Co., Limited.

THIS useful compilation gives in parallel columns the name of the town or place; the date of commencement of the undertaking; the special acts, if any; total paid up share capital, dividends, loan capital issued; the names of chairman, manager, and secretary, the owners; the population of the town, and its distance from London. In most cases the information given is correct to the best of our knowledge. But we find no mention of the Chiltern Hills' Company, which supplies the towns of Aylesbury and Tring, and which dispenses one of the finest waters which any town in England can boast.

CORRESPONDENCE.

AN EXAMINATION QUESTION.

To the Editor of the Chemical News.

SIR,—Would the examiner for the University of Cambridge Higher Local Examination kindly explain through your columns the nature of the answer he would expect to the following question, which is second on the chemical paper set this year, and which runs as follows:—"2. What is meant by the vapour-density of a body? Explain as fully as you can why and how the determination of the vapour density of a body enables chemists to ascertain the size of its molecule" (Italics ours).—We are, &c.,

THREE WHO WERE ASKED.

Value of Night-soil.—Prof. E. v. Wolff (*Biedermann's Centralblatt*) values nitrogen in this form at 12s. per kilo; phosphoric acid at 0.3s.; and potash at 0.2s. per kilo.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. c., No. 21, May 25, 1885.

Contribution to the History of Sulphur and Mercury.—M. Berthelot.—The author has observed that when gunpowder is drying at 60° a certain quantity of sulphur sublimes, carrying with it, mechanically, a small quantity of carbon and of potassium nitrate. The vapour tension corresponding to this slow sublimation, effected 380° below the boiling-point of sulphur at the normal pressure, is not appreciable by manometric determinations. It must be nul, or nearly so at temperatures of about 15°, since the author has met with no instance of sublimed sulphur having been observed in glass cases and tubes in which specimens of crystallised sulphur have been preserved for years. M. Berthelot observes also that the vapour of mercury retains the power of diffusion at normal temperatures. In a laboratory where there was a large trough of mercury there was also in a glass case at 2 metres from the ground and $2\frac{1}{2}$ metres from the trough a bottle of iodine having a ground glass stopper. There was neither mercury nor ammonia nor any volatile acid in the case, but it was opened from time to time. After some years the author observed that the outer part of the neck, near its junction with the stopper, was covered with a ring of red mercury iodide.

On the Peculiar Properties of the Electric Current produced by the Rheostatic Machine.—M. Gaston Planté.—The current of electricity obtained by means of the rheostatic machine discharged in quantity enables us to produce effects which cannot be obtained either with voltaic electricity alone or with the ordinary apparatus of static electricity.

Determination and Registration of the Charge of Accumulators.—MM. A. Crova and P. Garbe.—Not suitable for abridgment.

Phenomenon of the Crystalline Superfusion of Sulphur and on the Speed of the Transformation of Prismatic Sulphur into the Octahedral State.—M. D. Gernez.—The change of prismatic into octahedral sulphur presents, for decreasing temperatures, a retardation analogous to that which occurs in the inverse case for increasing temperatures. The prisms, if cooled after their production, are capable of changing into octahedral elements, but their transformation is not necessarily produced as soon as they arrive at the temperature at which it is possible. M. Mallard has recently proposed the name of crystalline superfusion for the state of unstable equilibrium of prismatic sulphur at temperatures where it may experience but has not yet undergone this change.

On the Composition of Hydrogen Persulphide, and on the Nacreous Modification of Sulphur.—P. Sabatier.—The author has succeeded in distilling hydrogen persulphide under a reduced pressure, and obtains a mobile, very limpid liquid of a bright, pale yellow colour, and of an extremely irritating odour. The author's analyses lead to the formula H_2S_5 , but the conditions of the experiment induce him to ascribe to the pure persulphide the formula HS_2 . An excess of sulphur is furnished by the portion decomposed at the outset of the operation, and doubtless also to a certain proportion of the vapour of sulphur carried over by the bisulphide.

Addition Product, PF_3Br_2 , obtained by the Action of Bromine upon Phosphorus Trifluoride.—H. Moissan.—In the production of this compound the presence of moisture must be carefully avoided. It is a liquid body, very mobile, of an amber colour, and gives

off copious fumes on exposure to the air. In presence of water it is violently decomposed, yielding hydrobromic, hydrofluoric, and phosphoric acids. At a temperature of 15° it is split up into phosphorus pentafluoride and pentabromide.

Bulletin de la Société Chimique de Paris.

Vol. xliii., No. 7, April 5, 1885.

Composition of the Gases from the Combustion of Pyrites, and on Glover's Tower.—M. Scheurer-Kestner.—Already noticed.

Production of Certain Aromatic Hydrocarbons.—R. D. Silva.—The author has formed certain hydrocarbons by the general method of Friedel and Crafts. Among these he has more particularly studied isopropyl-benzene, diisopropyl-benzene, and isopropyl-toluene.

Nitro-derivatives of Ethylene Hydride.—A. Villiers. The author describes a compound which takes its rise on the reduction of the potassium derivative of tetranitrated ethylene bromide, also the potassium compounds of the corresponding chloride and iodide.

Letter from A. Mermet to the Secretary of the Chemical Society.—The writer, referring to the notes of V. Meyer and Ladenburg on the preparation of hypochlorous anhydride in lectures, maintains that this preparation was effected ten years ago in the course of general and analytical chemistry at the Central School of Arts and Manufactures.

Biedermann's Central Blatt für Agrikultur Chemie.

Vol. xiii., Part 10.

Purification of the Waste Waters of Sugar Works.—A. Bodenbaender.—It is remarked that a sugar works consuming daily 4000 cwts. of beets furnishes as much foul water as a town of 20,000 inhabitants, and discharges as much organic impurity as a town of 50,000 inhabitants. The waste waters contain suspended matters, *i.e.*, fragments of beets, dissolved organic matter, both nitrogenous and non-nitrogenous, and salts, sulphates, chlorides, and phosphates. Hence all conditions for energetic putrefaction and the multiplication of bacteria are present. The author recommends precipitation followed by irrigation, except when the effluent can be conveyed into a large river, "the water of which will play the part of the soil."

Determination of Ammoniacal Nitrogen in Arable Soils.—A. Guyard.—Already noticed.

Changes experienced by the Nitrogen of Peaty Soils under the Influence of Substances used as Manures and Ameliorants.—P. Reder.—The changes consist principally in an increase of nitrogen in the form adapted for the direct food of plants—nitric acid—and a decrease of the unassimilable ammonia. The most effectual agent in this respect is potassium carbonate, followed by caustic lime and magnesia and calcium carbonate, which differ little among themselves. The addition of gypsum decidedly delays the formation of nitric acid, whilst quartz sand decreases it very considerably. The loss of nitrogen generally experienced in the decomposition of organic matter is diminished by all additions except sand and gypsum, but not prevented.

The Assimilability of the Phosphoric Acid contained in Rocks and in Arable Soil.—G. Lechartier.—From the *Comptes Rendus*.

Theory of Manuring and the Problem of Manurial Experiments.—Prof. G. Drechsler.—The author proposes the following theory:—The plant-food in store and the manurial plant-food are respectively two groups of matter differing much in their position and distribution in the soil, in solubility, in form of combination, and in their action upon the growth of plants, and must therefore not be confounded with each other. 2. The power of plants to take up from manure such food as they require

is different in every species, and may even vary in one and the same species for a single kind of food, according to the form of the manure and the nature of the soil. 3. The object of manuring is twofold:—(A). The removal of every existing (absolute or relative) minimum of plant-food by a sufficient supply of the deficient or insufficient foods. The kind of manure which has to fulfil this function might be called store-manuring. It is manuring the *soil*. (B). To supply to every plant in the most suitable form those foods which it requires, keeping in view at the same time the preservation of the store of food. This is manuring (feeding) the *plant*. With the recognition of this theory manurial experimentation must enter upon a new phase. The question is no longer essentially addressed to the soil, but primarily and especially to the plant. For every crop the first question is, therefore, for what food-principles and combinations it experiences a "manurial requirement," and for what it does not? When this question is answered follows the second:—What changes does the manurial requirement of each plant undergo under the influence of different soils (with stores of plant-food differing in quantity and quality) and of different atmospheric influences? The third question is:—With what manurial agents, and in what quantity is the ascertained manurial requirement in different soils to be most certainly and profitably satisfied?

Report on Manurial Experiments in the Province of Hanover in the year 1880.—Prof. G. Drechsler.—Comparative experiments on the action of soda and potash saltpetres on potatoes and on the influence of kainite.

Preservation of Ammonia in Farm-Yard Manure.—Dr. Troschke.—It was found that the addition of gypsum occasioned an evolution of hydrogen sulphide with brisk decomposition of the organic matter and loss of nitrogen. Two equal portions of farm-yard manure were mixed, the one with gypsum and the other with kainite. After three months the former was found to have lost 32 per cent of its nitrogen, and the latter only 10 per cent. An intense escape of hydrogen sulphide was observed in the gypsumised sample. The author places the salts he has examined in the following order as regards their power of retaining ammonia: magnesium chloride, magnesium sulphate, gypsum, carnallite, kieserite, kainite, krugite.

Part II.

Manurial Experiments with Precipitated Calcium Phosphate.—Löbbecke.—In these experiments made on heavy soils precipitated phosphate gave a better result than superphosphate.

Treatment of Vermin Hurtful to Plants.—For the so-called cotton-blight in fruit trees there is recommended a mixture of 50 grms. soft soap, 100 grms. crude fusel oil, 300 grms. alcohol at 90 per cent, and water enough to make up 1 litre. Aqueous solution of phenol is recommended for aphides. Even at 5° to 6° B. it does not injure the plants. It is also said to banish ants, hamsters, and moles.

Moniteur Scientifique, Quesneville.

Vol. xv., June, 1885.

Determination of Phosphoric Acid by Joulie's Method.—An extensive treatise which has appeared in 1872, 1873, and 1876, and is now reprinted. The author describes the citro-uranc method at great length. In an appendix which appeared in March last we have again a description of the uranic and of the "nitro-molybdic" method, which the author rejects as far as manures and phosphatic minerals are concerned.

Review of Foreign Chemical Researches.—G. de Bechi.—A series of extracts from the *Berichte Deutsch. Chem. Gesellschaft* and from *Liebigs Annalen*.

On Morine.—MM. Benedikt and Hazura.—The tincorial power of fustic is generally attributed to its propor-

tion of maclurine and morine. Yet extracts of fustic, which give excellent results in dyeing, are found to contain only small quantities of these substances. According to experiments made by M. R. Geigy, maclurine is not, properly speaking, a tinctorial body; it dyes mordanted fibres a dirty brownish-yellow, whilst morine, under the same circumstances, yields full yellow shades. The authors describes the preparation of morine, its behaviour with melting alkalies, with sodium amalgam, and with nitric acid. Maclurine and morine are both transformed by simple reactions into phloroglucine and an acid, the resorcylic in case of morine and the proto-catechuic in case of maclurine.

Recent Progress in Calico-printing.—Dr. O. Witt.—The conclusion of a very extensive treatise, which cannot be here reproduced.

Artificial Colouring-matters derived from Natural Tannins and from their Congeners.—Dr. O. N. Witt.—This paper is too bulky for abstraction. The author remarks that the distinction between tannins which colour the salts of iron blue and those which colour them green is less superficial than it seems at first glance. Those which give a blue colour, such as the tannin of nut-galls, are derivatives of pyrogallol, whilst those giving a green colour, such as the tannin of oak-bark, and of the different catechutannic acids, are derived from pyrocatechine.

Industrial Review.—Extracts from the *Journ. f. Prakt. Chemie*, and from the *Journ. of the Society of Chem. Industry*.

The New Alloys.—Perry F. Nursey.—An account of phospho-bronze, silicium-bronze, manganese-bronze, "delta-metal," aluminium-bronze, "silveroid,"—an alloy of nickel and copper and cobalt-bronze.

Foreign Patents.—Abridged specifications of three German patents.

Patents taken out in Berlin.—Four more German patents.

Patents Relating to Colouring-matters.—A further list of German patents.

Patents taken in France concerning the Chemical Arts.

Selection of Patents taken and Published in France in 1885 having reference to the Chemical Arts.—It is not easy to see the principal difference between these two last lists.

Academy of Medicine.—April 28.—A notice of a work by M. C. Girard on the sophistication of alimentary matters. It was announced that the official *éloge* of Claude Bernard would be delivered on May 19.

Chemical Society of Paris.—March 13.—A brief notice of the papers read at the meeting.

Society of Encouragement for National Industry.—Notices of the meetings of April 10 and 24.

Industrial Society of Mulhouse.—Meeting of April 8.—M. Resiger sent in a claim for prize No. IX. The committee decided that the question was not solved, as the colour proposed for marking tissues does not resist the operations of bleaching. M. Herlitschka proposes as a solution of prize No. XXI. (prevention of colours in printing attaching themselves to the colour-doctors) to electrify the doctors, but he had not put his idea to any experimental test. The same process had also been devised some years ago by M. Goppelsröder. The claim was therefore rejected. M. Noelting, on behalf of himself and M. Witt, read a note on the liquid binitro-toluol, a secondary product of the industrial preparation of binitro-toluol. At a supplementary meeting, April 23, certain additional prizes were proposed, and Dr. Ulrich sent in a paper on a new blue for printing belonging to the family of the indulines. This blue is advantageously fixed by means of tannin and ethyltartaric acid. This acid promises to be of service in other cases for the application

of colours soluble in alcohol. On steaming it is dissociated into tartaric acid and alcohol.

Tempered Glass.—F. Siemens.—From the *Journal of the Society of Arts*.

Journal für Praktische Chemie.
Vol. xxxi., Part 7.

Colorimetric Investigations.—F. Stohmann.—The author works according to the method of L. Thomson, which has been employed in his laboratory with satisfactory results for the last six years. He has determined the thermic values of the animal fats, of vegetable fats and oils; of the albumenoids, to which are appended meat, rye-bread, and wheat-bread; of the derivatives of albumen generated in the animal and vegetable system; of the carbohydrates; of mannite; of certain hydrocarbons; of acids and of alcohols.

Studies in Chemical Dynamics.—W. Ostwald.—In this fourth memoir the author continues his researches on the inversion of cane-sugar. He finds that the close proportionality of the speed of the reaction and the electric conductivity observed in different acids holds good at very different degrees of concentration, although a complete parallelism does not exist.

Preparation of certain Polyatomic Alcohols and their Derivatives by means of Hypochlorous Acid.—S. Reformatsky.—A preliminary communication on the combination of hypochlorous acid with unsaturated compounds. The author's object is to convert the chlorhydrines thus obtained into the respective oxides, and to obtain the desired polyatomic alcohols from the latter by the addition of the elements of water.

Synthesis of the Tertiary Saturated Alcohols from the Ketones.—A. Saytzeff.—The author has examined the behaviour of dipropylketone and diethylketone with iodethyl and zinc, and that of the former of these compounds with iodmethyl and zinc. In all these cases he obtained a compound of the ketone with zinc-alkyl, and on decomposition of the product with water the corresponding tertiary alcohols, ethyl-dipropyl-triethyl, and methyl-dipropyl-carbinol.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3rd Série. Tome xii., March, 1885.

This issue contains no chemical matter.

Cosmos les Mondes.

New Series, No. 16, May 18, 1885.

This issue contains no chemical memoirs.

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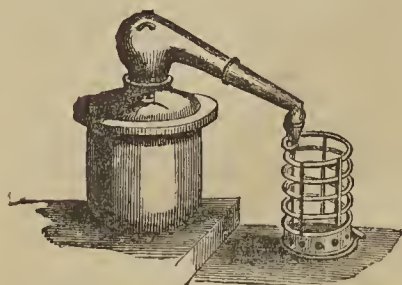
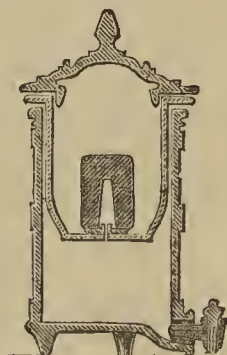
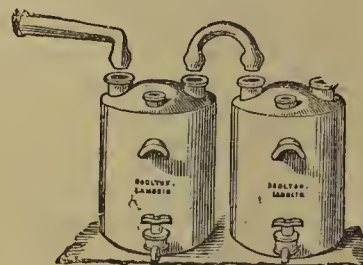
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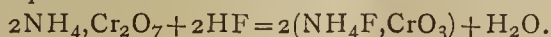
VOL. LII. No. 1337.

EFFECT OF HEAT ON THE FLUO-CHROMATES OF AMMONIUM AND POTASSIUM.*

By G. GORE, LL.D., F.R.S.

M. L. VARENNE has stated† that by adding an excess of hydrofluoric acid to a hot and concentrated solution of bichromate of ammonium, and evaporating and crystallising the liquid, a salt of a beautiful red colour is obtained, having when pure a composition represented by the formula $\text{NH}_4\text{F}_2\text{CrO}_3$, or $\text{NH}_4\text{O}, \text{CrO}_3, \text{CrO}_3\text{F}$, and that it attacks glass. Submitted in a tube to the action of heat it decomposes with energy, and leaves as a residue a dirty green powder. Sulphuric acid decomposes it immediately, setting free hydrofluoric and chromic acids. Also, "there is presented in the preparation of the salt a peculiar circumstance. During the boiling of the mixture of hydrofluoric acid and bichromate there is produced suddenly an evolution of gas in extremely small bubbles, and the edges of the platinum vessel containing the liquid are attacked, as well as the platinum spatula used as a stirrer. We perceive at the same time a peculiar odour, not resembling that of chlorine, and which appears characteristic. Shall fluorine be set free under these conditions, the same as, by the action of hydrochloric acid upon the same chromate, chlorine is sometimes liberated?"

With the object of verifying these statements I have examined the effect of heat on a mixture of pure dilute hydrofluoric acid and ammonium bichromate in the following manner:—1.175 grms. of the bichromate were dissolved in water in a platinum dish; an excess of the pure dilute acid was then added, and the liquid evaporated at a nearly boiling temperature. No signs of evolution of gas or corrosion of the vessel were observable during evaporation of the liquid and drying of the salt at 100°C . The dry salt corroded glass. The platinum dish suffered no perceptible loss of weight. The salt obtained weighed 1.347 grms., theory requiring 1.287 grms. to agree with the following equation:—



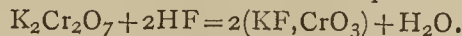
0.0925 grm. of the dried salt was slowly heated to redness in a platinum boat within a platinum tube retort. It hissed, decrepitated, and evolved a white fume having but little odour and no visible action on litmus-paper or glass, and probably consisted of ammoniac fluoride and oxygen in accordance with the equation—



It slightly discoloured a crystal of potassic iodide, probably by forming ammoniac iodide. The residue had the appearance of sesquioxide of chromium, and weighed 0.0518 grm.; the equation given requires 0.05146 grm. With a quantity of the salt weighing about 0.25 grm. the action was very rapid, the residual substance being blown out of the tube. The fumes did not affect a splint of wood wetted with spirit of turpentine; they had a slightly acid odour, and discoloured potassic iodide more strongly; pure dry hydrofluoric acid vapour, evolved by heating pure acid fluoride of potassium in the same vessel, did not discolour that salt.

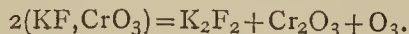
Similar experiments were made with the analogous potassium compound, 2.95 grms. of potassic bichromate and 1.60 grms. of pure dilute hydrofluoric acid of 28.69 per cent (= a proportion of one molecular weight of the former to a little more than two of the latter) were mixed

and dissolved in water in a weighed platinum dish, and the clear solution evaporated to dryness at 100°C . The residue was similarly heated during four more hours; it continued to lose weight slightly, but evolved no odour. The dry salt contained a small quantity of sesquioxide of chromium, and weighed 3.1764 grms., theory requiring 3.1698 grms., in accordance with the equation—



The dish was not corroded, and had not lost any weight.

0.4473 grm. of the salt was heated as above. It evolved a colourless vapour which corroded glass, and had an odour like that of hydrofluoric acid; sesquicarbonate of ammonia fumed in it, but a crystal of potassic iodide was not discoloured; a red-hot splint was not vivified in it. The residue weighed 0.3865 grm., theory requiring 0.38202 grm. if the reaction was in accordance with the equation—



It appeared like a mixture of green sesquioxide (or sub-fluoride) of chromium and a fused salt. By heating with oil of vitriol it evolved a colourless vapour which corroded glass.

No signs of evolution of free fluorine occurred in either of these experiments.

ON THE ESTIMATION OF CARBON IN IRON AND STEEL.*

By THOMAS TURNER, Assoc. R.S.M., F.C.S.,
Demonstrator of Chemistry, Mason College.

So many methods have from time to time been proposed by various chemists of eminence for the estimation of carbon in iron and steel, that an enumeration of them would occupy much more space than we have at our disposal. It will be generally acknowledged that Eggertz's colouration method for the estimation of "combined" carbon, especially with Stead's modification in the case of very small quantities, gives us a very ready and, on the whole, an accurate test for that portion of the work; but we have yet much to learn before total carbon and graphite can be as readily and accurately determined. Methods which involve combustions are generally regarded as being more reliable, but necessitate the use of cumbrous and costly apparatus, in addition to the risk and trouble of transferring the carbonaceous residue. In the following paper an account is given of a method which, it is believed, will be found less troublesome and more rapid than, though equally accurate as, the ordinary methods in use. It is not claimed as being new, except in a few particulars, but is rather a modified method, depending upon several more or less well-known processes.

During the last few years several modifications of the more ordinary method of estimating carbon have been proposed by various chemists, the object being to obviate the trouble and risk of transferring the carbonaceous residue. Thus Breneman† employs a small platinum tube fitted with a plug of asbestos for a filtering tube, and, after drying, the whole is introduced into a porcelain combustion tube and burned in the usual manner. The process has the usual disadvantage incidental to the use of a large combustion furnace, and the additional drawback that the substance cannot be seen by the operator. But it may be regarded as an advance upon the usual method of filtration in a separate tube, and transference of the dried residue. Another method has been proposed by Clemence,‡ in which a further advance is made. Here a platinum tube is employed, and is used both as a filtering tube and, after drying, as a combustion tube also, thus avoiding transference of the residue. But to this several objections may be urged. The prime cost of a platinum

* Read before the Birmingham Philosophical Society, June 11, 1885.

† *Comptes Rendus*, 1880, vol. xci., p. 989.

* Read before the Birmingham Philosophical Society, May 14, 1885.

† *CHEMICAL NEWS*, xlviii., p. 163.

‡ *CHEMICAL NEWS*, xlviii., p. 206.

tube of this kind is considerable, and would be very great if a stock of tubes had to be kept, as in the case where a number of analyses have to be performed. Further, with a metal tube it is impossible to tell with certainty when the combustion is complete, and at high temperatures it may reasonably be expected that the platinum would become somewhat porous and allow of the passage of gas. In addition, the life of such a tube would probably be but short, owing to the action of siliceous residues upon platinum when heated in presence of carbon. In the following arrangement an attempt is made to remedy these defects.

For the solution of the iron, copper chloride or sulphate is still often used, and it is stated that the precipitated copper is rather an advantage than otherwise, as it assists in the combustion of the graphite. But this is gradually going out of use, since it is found that combustion of the carbon in the residue does not take place until the copper is thoroughly oxidised, and this very often takes longer than the whole combustion when other methods are employed.

An excellent solvent is found in ammonium cupric chloride, and this is now extensively used. It may be prepared by dissolving 53.4 parts of ammonium chloride, and 85.4 parts of crystallised cupric chloride in hot water and crystallising.* If the solution is not clear a little hydrochloric acid may be added; the crystals must then

tion that the solvent is hydrochloric acid instead of copper salt. Generally 2 grms. of iron is taken, but a somewhat larger quantity is used when the percentage of carbon is low. The iron being completely dissolved, the solution is then allowed to subside for a few moments and filtered.

For filtration a tube is employed, arranged as in Fig. 1. The tube itself is of ordinary glass combustion tubing, drawn out at one end, and constricted slightly at the junction of the broad and narrow part. The total length is 11 inches, the broad part being 8 inches long. At A is placed a small pea of baked clay, or some other suitable material, to act as a support; upon this is placed about half an inch of sand, which has been heated strongly in a crucible, with about 5 per cent of nitre to remove any organic matter. Upon this is placed a small plug of asbestos to act as a filter, and upon this again is about a quarter of an inch of the ignited white sand. By means of a small funnel the solution is introduced, while the narrow end of the tube passes through the cork of a flask connected with a filter-pump. To ensure rapid filtration one should begin with a small pressure, and *gradually* increase this, as necessary; and, of course, the precipitate should be put in last. The residue is washed twice with hot dilute hydrochloric acid, and then with distilled water. The tube is then gently warmed by means of a Bunsen burner, and a stream of air aspirated through the residue until it is

FIG. 1.

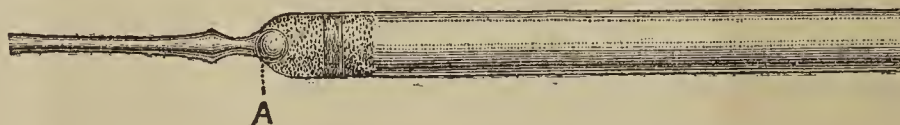
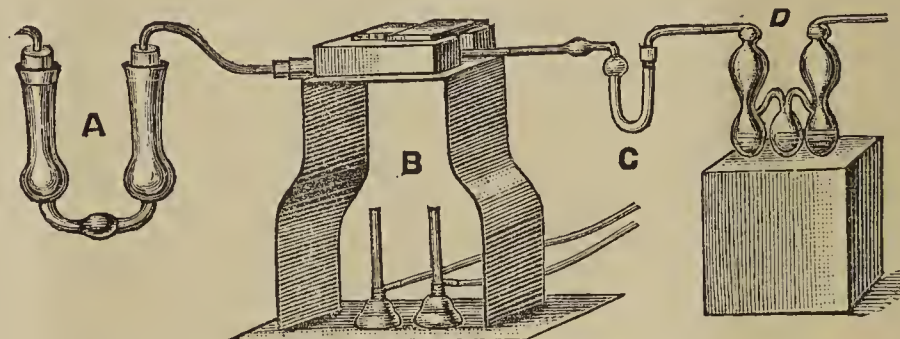


FIG. 2.



A. Potash tube. B. Combustion furnace. C. Drying tube. D. Potash bulbs.

be washed with water and dried by pressure. The salt is permanent in the air. One uses 15 grms. of salt, dissolved in 50 c.c. of water, per grm. of iron taken. After about 15 minutes a gentle heat is applied, and the mixture occasionally stirred until the copper is entirely dissolved. After filtering the residue is washed with warm dilute hydrochloric acid, and should burn white or very nearly so.

A solution which is cheaper, though not quite so effective in its action, may be prepared by dissolving 360 grms. of crystallised copper sulphate in about 750 c.c. of hot water, and gradually adding 310 grms. of common salt. If the temperature is raised to near the boiling-point a precipitate of anhydrous sodium sulphate will form; but this is immaterial. The solution is allowed to cool, when sodium sulphate should crystallise out; the liquid is passed through a filter, and the filtrate made up to a litre. Then 50 c.c. of this solution is capable of dissolving 1 grm. of iron, leaving a residue free from copper. The solution is effected in the same manner as before. When one desires the solution to be more rapid a larger amount of the copper solution may be employed. For the estimation of graphite the method of procedure is exactly the same as for total carbon, with the single excep-

quite dry. The object of the lower layer of sand is chiefly to remove the residue from the constricted part of the tube, because that portion would be liable to collapse in the next part of the process, in which the tube has to be very strongly heated. The upper layer of sand stops the larger particles of the residue and prevents the asbestos becoming clogged, and so greatly assists in the filtration; it also serves to distribute the residue, and thus causes it to burn more readily than it would do if it were compact. It is important, however, to avoid the use of too large a quantity of sand, as in that case the bulk of the residue which has to be dried is considerable, and much time is lost or inconvenience occasioned. When properly worked this method should give very little, if any, greater bulk of total residue than that obtained by solution in copper sulphate. If need be, in iron containing little silicon, solution and filtration may be completed in an hour, and the residue obtained in a form fit for direct combustion; and, as there is no transference, with a little experience, a determination of total carbon may be performed in two hours. The tube itself should last a number of combustions, though it is preferable to remove the residue after each operation, so as to avoid double error in case of any mistake. The residue being prepared and dried, it has now to be burnt.

* "Watts's Dictionary," vol. ii., page 53.

For this purpose a special form of simple combustion furnace is employed.* It consists of a stand made of sheet iron about $4\frac{1}{2}$ inches broad, $8\frac{1}{2}$ inches high, 4 inches long at the top, and $8\frac{1}{2}$ inches long at the bottom, being made taper for greater steadiness and convenience. This stand supports a sheet iron trough about 5 inches long, for the purpose of carrying the combustion tube. Fire-bricks are used to obtain the necessary temperature, and two fair-sized Bunsen burners are employed as a source of heat. This furnace, which is simple and inexpensive, and which stands upon an ordinary working bench, though originally devised for the purpose here mentioned, has since been found very useful for many purposes in the laboratory for which a more complicated form was previously required. The temperature obtained is sufficient to thoroughly soften good combustion tubing, and to cause graphitic residues from cast-iron to burn in less than an hour in a current of air.

The operation of combustion is, of course, very similar to that usually adopted, except that all is in miniature and on a working bench. A drying tube and potash bulbs are attached to the narrow end of the glass tube, while a cork and tube is attached to the open end. By means of an aspirator a slow stream of air free from carbon dioxide is drawn through the apparatus, and heat gradually applied. The residue is noticed from time to time, and when the silicon has burned white, or light brown with iron rich in silicon, the combustion is completed. This is accomplished, in the case of steel, in half an hour from the time when the full heat is applied, and I have never yet had an iron requiring more than an hour. In other words, the whole combustion often takes less time than the mere oxidation of the copper alone, in a stream of oxygen, when the copper sulphate method is employed. In Fig. 2 a sketch is given of the complete apparatus, the aspirator alone being omitted.

The following experiments were principally performed by Mr. A. E. Jordan, a student in the Mason College Chemical Laboratory, who has recently compared the method given in this paper with the older plan of solution in copper sulphate. In the first column are results obtained by the use of a long combustion furnace, and over a foot of copper oxide, the iron being dissolved in copper sulphate. In the second column are results obtained with much simpler apparatus and less trouble.

	I.	II.
Total carbon, Siemens Martin Steel ..	0.74	0.75
Total carbon, Silicon Pig	1.81	1.71
		1.72
Graphite, Silicon Pig	1.12	1.06
Total carbon, Grey Pig Iron	3.09	2.90

It will be seen that as the amount of carbon increases the results become rather low, but this difference is never very much greater than the allowable limit of experimental error in such analyses, and the figures in the second column are possibly as much to be relied upon as the others.

We may therefore conclude as follows:—The proposed method has the advantage of simple and inexpensive apparatus which can be used on an ordinary working bench; it obviates the trouble and risk of transference, and enables the operator to see when the combustion is complete. The operations are simple and rapidly performed, the use of oxygen is dispensed with, while results of considerable accuracy are obtained.

Comparison of the Barleys of Different Countries.

—L. Marx.—The most highly nitrogenous barleys are those of Russia and Baden; then follow those of Sweden, North Germany, Alsace, Hungary, and France. England and Austria come lowest, with respective means of 9.69 and 9.61 nitrogen.—*Biedermann*, vol. xiii., part 12.

* This may now be obtained from Messrs. Southall Bros. and Barclay, Birmingham, for a few shillings.

A LECTURE EXPERIMENT ON RECIPROCAL COMBUSTION.

UPON the gallery which supports the lamp-glass of an Argand burner place a bottomless half-pint beaker, mouth upwards. Let the gas burn from the ring of holes for a minute or two, to warm the beaker and burner, turn the flame down till the white luminous part is very small, and cover the mouth of the beaker with a metal plate or a clock-glass, containing a little water to prevent cracking. The gas will cease to burn from the ring of holes, but the air entering through the central tube of the Argand burner will burn in the gas with a pale flame, which may be made visible from a distance by thrusting up the central tube a loop of copper wire wetted with ammonium chloride to produce the vivid green colour.

C. L. B.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from p. 4).

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
- || Following a date signifies publication discontinued.

81. FORTSCHRITTE (DIE) AUF DEM GEBIETE DER TECHNISCHEM CHEMIE. 1874-'76. I no., 8vo. Leipzig, 1877.
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82. FORTSCHRITTE (DIE) AUF DEM GEBIETE DER THEORETISCHEM CHEMIE. I no., 8vo. Leipzig, 1874.
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- [a] Gazzetta eclettica di chimica farmaceutica medica tecnologica e di rispettiva letteratura e commentario della conversazione chimico-farmaceutica. Red.: Sembenini. — vols., 8vo. Verona, 1835-'37.
Serie terza. — vols. 1838, '39 [+?]
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* Advance-proofs from the *Annals of the New York Academy of Sciences*.

87. GAZZETTA DI FARMACIA E DI CHIMICA che da prima pubblicavasi in Este. 8vo. Venezia, 1855-'57.

GEHLEN, A. F.

See Allgemeines Journal der Chemie [a]; also, Repertorium für die Pharmacie.

GEIGER, PH. LORENZ.

See Annalen der Pharmacie.

GEIGER'S MAGAZIN.

See Nordische Blätter für Chemie [b].

GILBERT'S ANNALEN.

See Journal der Physik. Gren.

(To be continued.)

ON LAKMOID, LITMUS, PHENOL-PHTHALEIN, AND OTHER INDICATORS.

By ROBERT T. THOMSON.

I FORMERLY contributed to the CHEMICAL NEWS (vol. xlvii., pp. 123 and 184; xlix., 32 and 119) four papers on the properties of several of the best indicators, and the uses to which they may be applied. In the following paper I have resumed the study of the same subject, but with special reference to the new indicator,—the lakmoid prepared from resorcin.

I. Characteristics and Classification of Indicators.

Lakmoid, as far as its properties as an indicator are concerned, has been declared to resemble litmus in its properties. Such a view is sustained merely by a few experiments on the carbonates of the alkali metals and calcium, and is therefore an extremely superficial and mischievous one, as will be abundantly proved by the results to be described. In order to classify indicators correctly an extended survey of their characteristic properties must be taken. And this I have attempted to do, as far as possible, for litmus, rosolic acid, methyl-orange, phenacetolin, and phenol-phthalein in previous papers, and chiefly for lakmoid in the present one. We find on examination that all these indicators, when used in testing the pure hydrate of an alkali metal or an alkaline-earth metal with a strong mineral acid (sulphuric, hydrochloric, or nitric), or *vice versa*, have each exactly the same characteristics, or, in other words, show neutrality at precisely the same point. But when a weak acid, inorganic or organic, is employed in conjunction with these alkalies, we find the indicators dividing themselves into well-defined groups. Methyl-orange and lakmoid, in the case of the phosphates for example, show the neutral-point when the most acid phosphate is produced, phenol-phthalein when the medium salt is formed, while with litmus, rosolic acid, and phenacetolin no very definite result is obtained. The latter class seem in their properties to lie between lakmoid and methyl-orange on the one hand, and phenol-phthalein on the other. There may be, and are, exceptions to these general rules, as, for instance, the notable one of rosolic acid employed in titrating sulphites, in which case that indicator groups itself with phenol-phthalein in its behaviour. Basing our classifications on facts such as those referred to, we may divide the indicators into three groups,—(1) *Methyl-orange and lakmoid*, which are most sensitive to alkalies, or show the alkali to be more powerful than the acid; (2) *Phenol-phthalein*, on which acids have a predominating influence; and (3) *litmus, rosolic acid, and phenacetolin*, which lie in an almost indefinable position between the first and second groups. This grouping shows at a glance that a certain solution, for instance, may be acid to phenol-phthalein, and even to litmus, and yet be alkaline to lakmoid.

II. Preparation and Properties of Lakmoid.

Lakmoid is not yet an article which can be purchased, but happily it can be easily prepared. This was done according to the directions of Traub and Hock, 100 parts

resorcin, 5 parts sodium nitrite, and 5 parts water were heated at a temperature not exceeding 120° C. till ammonia ceased to be evolved. The blue mass was dissolved in water, the lakmoid precipitated by hydrochloric acid, collected on a filter, and washed. The solution was prepared by dissolving the lakmoid in 50 per cent alcohol. Blue and red lakmoid-papers may be prepared in a similar way to litmus-paper, the alcoholic solution being rendered blue by the addition of a minute quantity of caustic soda, or red by a sufficient proportion of dilute sulphuric acid.

One used to the end-reaction of litmus is apt to be deceived at first by that of lakmoid, in titrating an alkali with an acid. The red colour produced by the latter indicator is not like the bright litmus-red, but has a distinct purple shade, even in presence of excess of acid. In the form of paper lakmoid is an extremely delicate indicator, and one of its useful properties is due to the firm hold the colouring matter has on the paper, so that it is almost impossible to remove the colour by washing with water. This is a matter of some importance, as will afterwards be seen, in testing highly coloured solutions, which mask the colour of the test-paper, and thus require to be removed by washing with water. The water employed for this purpose must be carefully tested to make sure that it is neutral to lakmoid paper, as the presence of minute quantities of carbonates may change red paper distinctly blue.

The delicacy of the lakmoid, with reference to the proportion of acid or alkali required to transform the colour entirely, was tested with 100 c.c. of distilled water and 0.5 c.c. of the indicator solution containing 1.5 gm. of the solid lakmoid per litre. To change the colour completely under these conditions, 0.1 c.c. of decinormal acid or alkali was consumed. The following table gives the results obtained with the indicators I have treated of in previous papers:—

TABLE I.

Showing Delicacy of Indicators in Absence of Interfering Agents.

Amount of distilled water used for each test, 100 c.c.
Amount of indicator solution used for each test, 0.5 c.c.

Name of Indicator.	Grms. of Solid Matter per litre of Indicator Solution.	N/10 Acid or Alkali required to change colour of Indicator.
Methyl-orange	0.15	0.5 c.c.
Lakmoid	1.5	0.1 "
Litmus	20.0	0.5 "
Rosolic acid	2.0	0.1 "
Phenacetolin.. ..	2.0	0.1 "
Phenol-phthalein	0.5	0.1 "

It must be noted, in connection with the above table, that the strengths of the indicator solutions there given were such that equal volumes of each gave, as nearly as could be judged from their different tints, the same intensity of colour at the point at which the change caused by the addition of excess of acid or alkali was just complete.

III. Determination of Alkali in Pure Hydrates of Sodium, Potassium, Ammonium, Calcium, and Barium.

Nothing more need be done than to state that when these compounds are titrated with sulphuric, hydrochloric, or nitric acid, accurate results are obtained, the end-reaction both with lakmoid solution and paper being very delicate.

IV. Determination of Alkali in the Carbonates and Bicarbonates of Sodium, Potassium, and Ammonium.

For these experiments 2.65 grms. of pure carbonate of sodium, and equivalent proportions of the carbonates of potassium and ammonium, were used. On the addition of 49.5 c.c. of normal sulphuric acid to the cold solution, the blue colour showed decided signs of purpling,

and the end-reaction was rather indistinct at 50 c.c. Another experiment, in which the solution was boiled to expel carbonic acid when nearing the neutral-point, gave a very decided end-reaction, 50 c.c. of the acid being consumed, which is exactly equal to the amount of alkali present. These tests were made only with the sodium and potassium compounds. The test with carbonate of ammonium had, of course, to be done cold. It was found that the lakmoid-papers could be used in the cold with great advantage for all three compounds. Although the solution was saturated with carbonic acid at the last stages of the reaction, yet the red paper showed the least trace of alkali remaining. The blue paper is very slightly affected by the carbonic acid, when only traces of alkali remain unneutralised; but even this faint reddening is dispelled by removing the paper from the liquid, and exposing it to the air for a few seconds. Very accurate results are thus obtained in cold solutions, in the determination of the alkali in carbonates and bicarbonates of sodium, potassium, and ammonium.

V. Determination of the Base in Carbonates of Calcium, Barium, and Magnesium.

These, as with the other indicators, can only be tested, with lakmoid by adding excess of standard acid and titrating back with soda.

Lakmoid, as has been pointed out by Mr. Draper (CHEMICAL NEWS, vol. li., p. 206), is a very delicate test for carbonates of lime and magnesia in water, and is in fact superior to any of the indicators I mentioned in connection with this subject formerly (*Ibid.*, xlix., 34). It can be used for the determination of the hardness of water by Iehner's method, which is described in the paper referred to.

VI. Sulphites of Sodium, Potassium, Ammonium, Calcium, and Magnesium.

The normal sulphites of these metals are all strongly alkaline to lakmoid, as they also are to litmus. The sulphite of sodium test may be taken as a type of the results of the experiments with the other sulphites, as they were all found to act in precisely the same manner. A solution containing 3.15 grms. of sodium sulphite, which contains 1.55 grms. of soda, was employed. Normal sulphuric acid was now run in, and when about 22 c.c. had been added the blue colour became purple. The change was gradual on further addition of acid, and as the red lakmoid colour has a distinct purple, the last change was extremely difficult to hit, even when compared with a fully reddened lakmoid solution of equal strength. To accomplish the neutralisation 24.9 c.c. of the normal acid was required. This is equal to 0.771 gm. of soda, or almost exactly half of that really present, showing that the acid sulphite of sodium (NaHSO_3) is practically neutral to lakmoid. The papers give a more definite, and even tolerably accurate, end-reaction. But in testing with the paper the colour must be judged of immediately after removing from—or, better, while immersed in—the liquid. This is a matter which must be carefully attended to, as otherwise the paper which may show a distinct acid reaction when just removed from the liquid, would become strongly alkaline by exposure to the air for a few seconds. This change is immediate if gentle heat be applied to the test-paper, and is without doubt due to the decomposition of the acid sulphite of sodium and formation of some normal sulphite, which is alkaline.

These facts are equally true of the sulphites of potassium, ammonium, calcium, and magnesium.

With the sulphites begins the difference between lakmoid and litmus. When the latter indicator is employed in titrating sulphites with acids, it becomes purple before one-fourth of the soda is estimated, while with lakmoid nearly one-half is determined before this point is reached. But as more definite results are obtained with both indicators when in the form of paper (and especially is this the case with litmus) it will be preferable to compare them under

this more favourable condition. A solution containing 1.57 grms. sulphite of sodium consumed 12.5 c.c. of normal acid with lakmoid-paper, while with litmus-paper the neutral-point was indicated after the addition of 4.4 c.c. With the former indicator 50 per cent of the soda present is thus determined, while with the latter only 17.7 per cent can be estimated.

VII. Thiosulphate of Sodium.

This is exactly neutral to lakmoid.

VIII. Sulphides of Sodium, Potassium, and Ammonium.

As in my earlier series of experiments, a quantity of solution containing 0.284 gm. of normal sodium sulphide (Na_2S), prepared by adding sodium hydrate to solution of sulphuretted hydrogen, was employed. When about 4 c.c. of normal sulphuric acid had been added, the colour of the lakmoid, which had begun to purple, was slowly bleached until only an almost imperceptible brownish tint remained. The estimation was finished with lakmoid-papers, and excellent results were obtained, 7.2 c.c. of normal acid being consumed. This is equal to 0.280 gm. of Na_2S . The bleaching effect seems to be due to the liberated sulphuretted hydrogen, as I found that when a solution of that gas was coloured with the lakmoid the decolourisation took place within two or three minutes. In hot solutions the colour is dispelled almost instantaneously. The same phenomenon was observed when acid sodium sulphide (NaHS) was substituted for sulphuretted hydrogen solution, but with the normal salt (Na_2S) the indicator was little if at all affected. Curiously enough, when excess of caustic soda was added to the apparently bleached solution the blue colour gradually returned, and this was reddened by acid, and decolourised again by the action of the liberated sulphuretted hydrogen. This restoration of the blue colour by the addition of excess of soda was observed after the lakmoid had been exposed to a saturated solution of sulphuretted hydrogen for twenty-four hours.

These experiments show clearly that lakmoid solution cannot be used as indicator in presence of sulphides, but that the paper gives trustworthy results; in which case the whole of the sodium sulphide is determined by standard acid.

Identical results, in every particular, were obtained when the tests quoted above were applied to the sulphides of potassium and ammonium.

IX. Phosphates of Sodium, Potassium, Ammonium, and Calcium.

The best salt to start with is the disodium hydrogen phosphate (Na_2HPO_4), as it is most easily got pure, and is besides the most convenient to test indicators with, the normal salt (Na_3PO_4) merely containing a useless (so far as our present purpose is concerned) extra atom of sodium. The quantity operated upon was 1.775 grms., which is equal to 0.775 gm. of Na_2O . On adding the normal acid the blue colour remained unchanged until 11.4 c.c. had been run in, when it assumed a purple tinge. The end-reaction, owing to the gradual reddening after this stage was reached, was rather indistinct. As nearly as could be judged 12.4 c.c. were consumed, which gives 0.384 gm. of soda, or very nearly half of that really present. This shows that the most acid phosphate (NaH_2PO_4) is practically neutral to lakmoid. It is preferable, however, to use the paper instead of the solution, as a very well-defined end-reaction is obtained. Indeed I think that lakmoid-paper is to be preferred before methyl-orange for this purpose, and could be substituted for that indicator in the volumetric determination of phosphoric acid described in a previous paper of mine (CHEMICAL NEWS, xlvii., 85).

An experiment was now made with an amount of sodium phosphate equal to that used for the tests quoted above, but with litmus-paper as indicator. The end-reaction is not nearly so delicate as with lakmoid, but, as

nearly as could be ascertained, 3.4 c.c. of normal acid were consumed to render the solution neutral. It will thus be perceived that, while with lakmoid-paper 50 per cent of the soda in Na_2HPO_4 is estimated, with litmus only 13.6 per cent is obtainable.

It was also ascertained by other tests that the corresponding compounds of potassium (KH_2PO_4), ammonium ($\text{NH}_4\text{H}_2\text{PO}_4$), and calcium (CaH_4PO_4), were all exactly neutral to lakmoid.

X. Arsenates of Sodium, Potassium, and Ammonium.

The facts stated above, regarding the phosphates, are also true of the analogous arsenates of sodium, potassium, and ammonium. That is, NaH_2AsO_4 , KH_2AsO_4 , and $\text{NH}_4\text{H}_2\text{AsO}_4$ are all neutral to lakmoid.

In estimating arsenic acid by the volumetric method the lakmoid-paper may be substituted for methyl-orange (see CHEMICAL NEWS, xlix., 120).

XI. Arsenites of Sodium and Potassium.

The whole of the base is estimated in these by standard acid, showing that arsenious acid (H_3AsO_3) is neutral to lakmoid. The end-reaction, both with solution and paper, leave nothing to be desired in point of sensitiveness.

XII. Borates of Sodium, Potassium, Ammonium, Calcium, Barium, and Magnesium.

For a test experiment 1.683 grms. of pyroborate of soda ($\text{Na}_2\text{B}_4\text{O}_7$) were employed. The lakmoid purpled slightly towards the end of the reaction, but the neutral point was indicated with great delicacy, and especially was this the case when the paper was used. To effect the neutralisation 16.65 c.c. of normal acid was required, which is equal to 0.516 gm. Na_2O , or exactly the proportion present. I formerly had occasion to show that methyl-orange was our only perfect indicator for determining the total soda in borax, the others giving very indistinct end-reactions. It was also found that the total base could be determined in the borates of potassium, ammonium, calcium, barium, and magnesium, by titration with standard acid, when either lakmoid or methyl-orange was used as indicator. If the blue paper be applied to a strong boiling solution of pure boric acid a slight purpling is observed, but this effect is not perceptible in the cold. Thus lakmoid may be used as well as methyl-orange in testing boracic acid, for borates, or for acidity stronger than that of boric acid. In testing the alkalinity of commercial borates of lime or boracite, it will be necessary to add excess of standard hydrochloric or nitric acid, and titrate back with standard alkali. But in many cases such as these, where there may be insoluble matter present or the solution may be coloured, the lakmoid-paper can be applied directly, while the solution or methyl-orange might not be capable of application.

XIII. Silicates of Sodium and Potassium.

The whole of the soda or potash existing as silicate is estimated when titrated with standard acid, and using lakmoid as indicator. With either solution or paper the end-reaction is very distinct. It is unnecessary to record the results.

XIV. Alumina.

Soluble alumina is usually present in caustic soda or potash, and also in the carbonates of these bases, and it was therefore desirable to see what effect it would have on the determination of alkali. A quantity of pure aluminium hydrate, equal to 0.515 gm. Al_2O_3 , was prepared from alum by precipitation with ammonia, collected on a filter, washed, re-dissolved, re-precipitated, collected again, thoroughly washed, dissolved in 125 c.c. of normal caustic soda, and made up to 250 c.c. with water. To 50 c.c. of this, lakmoid solution was added, then normal acid. The alumina seemed to be all precipitated after the addition of about 25 c.c., and after that the addition of a few drops

of the acid caused a temporary reddening, which was quickly changed to blue as the alumina dissolved in the acid. This reddening and reappearance of the blue went on until 30.5 c.c. in one test, and 30.6 c.c. in another, were consumed. The end-reaction was not very sharply defined, but tests made with red and blue lakmoid-paper gave substantially the same number of c.c. as that stated had been added. It seems rather curious that the insoluble hydrate of aluminium should change the red paper to blue, but it does so very strongly. These results show 0.946 gm. Na_2O as against 0.775 gm. really present, or, if the difference be calculated to alumina, gives 0.094 gm. in place of 0.103 present. Tested with methyl-orange, as I had occasion to show before, the same amounts of soda and alumina gave, when titrated with acid, 0.951, while with litmus 0.782 gm. of soda was obtained. Here again lakmoid is shown to be similar to methyl-orange, and quite different from litmus in its behaviour.

(To be continued.)

A NEW AND RAPID METHOD OF GERMAN SILVER ANALYSIS.

By THOMAS MOORE.

THE manufacture of copper, nickel, and zinc alloys, generally classified under the comprehensive title of German silver, has within late years increased to such an extent that many of the manufacturers who formerly made only a given number of qualities find themselves now called upon to make alloys of very exact composition, and so keen has the competition become that a variation of 1 p. c. on nickel contents would now scarcely be tolerated. One obvious result of this competition is that the analysis of the alloy has become more the rule than the exception, and as time is an important factor, I venture to hope the under-noted process will prove useful to those engaged in such analysis. Hitherto, the only difficulty in German silver analysis was the separation of the zinc from the nickel, but now, thanks to Zimmermann's ammoniac sulphocyanide method, this has almost disappeared, and were it not for the introduction of ammoniac salts into the nickel solution the process would be all that could be desired.

The following is the process I employ, which includes a zinc from nickel separation, which, I think, is quite new, and is also very accurate, and also a new way of dissolving the copper sulphide, by means of which a considerable saving in time is effected.

Dissolve 0.5 gm. of the alloy in *aqua regia* and evaporate to dryness over the water bath; to the dried residue add 25 c.c. hydrochloric acid, sp. gr. 1.160, dilute to 250 c.c. with distilled water, keep the solution at 70° C., and precipitate the copper with sulphuretted hydrogen; filter and wash out with hydrochloric acid, sp. gr. 1.05, which is saturated with sulphuretted hydrogen and then with water containing that gas in solution; by so proceeding, a second precipitation is thus avoided (*Gerh. Larsen*); wash the precipitate into a beaker glass, and dissolve it by adding potassic cyanide. Heat facilitates the solution, which takes place in a few seconds, and do not use more cyanide than is necessary to effect the complete solution, except perhaps a small black insoluble residue of plumbic sulphide or a yellowish powder of separated sulphur. Add to the solution so obtained 20 c.c. of a strong solution of ammoniac carbonate and dilute to about 250 c.c.; boil for a minute or two, and submit the solution to electrolysis, keeping it about 70° C. and occasionally adding a little of the carbonate solution. I use three Bunsen's cells, pint size, and find that from two to three hours are amply sufficient for the complete deposition. The deposited copper has a brilliant and compact appearance, and is dried and weighed in the usual manner.

The filtrate from the copper precipitate is evaporated to dryness, the residue dissolved in water, and sufficient pure potassic cyanide added to dissolve the precipitate first formed. Any iron present will be left partially undissolved, but that will not influence the results. Wash the solution into a flask of 600 c.c. capacity and add colourless or but slightly coloured ammoniac sulphide (not the yellow sulphide); dilute to about 400 c.c., place a funnel in the mouth of the flask, and a spiral of platinum wire in the flask to prevent bumping; boil until the steam has no action on test papers. A double decomposition takes place, ammoniac cyanide is volatilised, while zinc sulphide is precipitated, which is filtered off and washed with boiling water containing sufficient sodic carbonate to make it distinctly alkaline. The filtration of the precipitate so obtained does not present the slightest difficulty, the sodic carbonate preventing any of the sulphide passing through the paper, which, when well washed out, is dissolved and converted into the carbonate and weighed as oxide in the usual manner. If any iron is present, separate from the weighed oxide by repeated solution and precipitation with hydrochloric acid and ammonia, and add it to the other portion of the iron separated from the nickel solution.

The filtrate containing the nickel is acidified with hydrochloric acid, and digested in a warm place with bromine until a clear solution is obtained; or evaporate to dryness with *aqua regia*, and precipitate the solution obtained by either method with potassic hydrate and bromine, filter off the black precipitate, wash well and dissolve off the filter with dilute sulphuric acid, add excess of ammonia and electrolyse hot. Any iron which separates out filter off and weigh.

CIDER AND VINEGAR.*

By W. FRENCH SMITH.

THIS investigation was commenced in September, 1882, to ascertain the maximum and minimum percentages of alcohol and acetic acid which genuine apple juice would produce.

In each case the apples were selected and the juice expressed under my own supervision, and the cider was allowed to ferment slowly for two months in a cellar, at an average temperature of 14° C. At the expiration of this time the alcohol was determined by the ordinary method of distillation and specific gravity. Duplicate estimations were made with each sample.

The ciders numbered I. to VI., inclusive, were of agreeable flavour and aroma, but VII. and VIII. were barely palatable.

Cider No. I. prepared from selected apples of the variety generally known as "August Sweets," gave 9.40 per cent alcohol.

Cider No. II., from average "August Sweets," gave 6.05 per cent.

Cider No. III., from "August Sweets" not thoroughly ripened, gave 4.80 per cent.

Cider No. IV., from selected "Porter" apples, gave 4.85 per cent.

Cider No. V., from "Porter" only partially ripened, gave 4.05 per cent.

Cider No. VI., from "Greening" apples picked from the trees, gave 4.00 per cent.

Cider No. VII., from "Greening" apples taken from the ground, gave 3.85 per cent.

Cider No. VIII., from poorest "Greening" apples taken from the ground, gave 3.00 per cent alcohol.

The average of these determinations is five per cent.†

These results indicate that a good cider should contain about five per cent, and a fair sample ought not to fall below four per cent of alcohol, and if it is less than 3.5 per cent the cider must have been diluted, or prepared from extremely bad apples, for in number VIII. I endeavoured to select a fruit which would produce a cider of the lowest possible alcoholic strength. In my opinion cider made from such apples is unsuitable for use.

In the autumn of 1883 I determined the acidity and solid residue in the first six of these samples. Nos. VII. and VIII. could not be protected from putrefactive decomposition during the summer of 1883.

The acid was estimated by titration with standard sodium hydrate, and the residue by evaporation and drying at 100° C.

Vinegar No.	Per cent of acetic acid.	Per cent of solid residue.
I.	10.10	3.64
II.	6.80	3.35
III.	5.65	3.10
IV.	5.70	3.20
V.	4.40	2.70
VI.	4.45	3.22
Average	6.18	3.20

The actual amounts of acetic acid found are lower than the alcoholic percentages in the original ciders demand, but this can be explained by imperfect acetification. I find manufacturers pretty generally agree that perfect conversion, by the cellar process, requires from two and a half to three years. I regret that I was unable to examine these samples again, later, owing to an accident.

The percentages of alcohol found in the original ciders would require the following acidities, if the oxidation had been complete, viz.:—I., 12.22 per cent; II., 7.86 per cent; III., 6.24 per cent; IV., 6.30 per cent; V., 5.26 per cent; VI., 5.20 per cent.

Theoretically, one part of alcohol should yield about one and one-third parts of acetic acid; practically, the manufacturers realise about one part acid for each part of alcohol. Calculating upon this basis, the averages of the vinegars produced by the first six ciders would be 5.53 per cent acid.

While a genuine cider vinegar may contain less than 4 per cent acetic acid, it is evident that a good article should consist of about 5 per cent, and vinegar prepared from the better grades of cider will represent from 5.5 to 7 per cent acidity.

I believe that apples must be *carefully selected* to yield a vinegar above 7 or 8 per cent.

It is noticeable that samples V and VI. could be preserved, while putrefactive decomposition could not be arrested in Nos. VII. and VIII. In one case the difference in alcoholic strength is only 0.15 per cent.

The lowest solid residue is 1.2 per cent higher than the figure defined in the Massachusetts Statutes as the minimum for a merchantable vinegar, *i. e.*, 1.5 per cent, while the average is more than double this standard.

Speed of the Transformation of Prismatic Sulphur into the Octahedral State.—D. Gernez.—The author studies the influence of the surrounding temperature upon the rate of transformation. It is very slow about 97°, becomes more rapid at decreasing temperatures, reaching a maximum between 55° and 44°, but becoming slower again at lower temperatures. Other factors are—the influence of the temperature at which the prisms have been produced; the influence of the duration of the prisms in the bath where they originated; influence of the temperature at which the sulphur has been melted before its solidification in prisms; influence of the stay of the sulphur in the melting-bath; influence of anterior operations to which the sulphur has been submitted.—*Comptes Rendus*, vol. c., No. 22.

* From the *Journal of the American Chemical Society*, vol. vii., No. 4.

† These percentages are by weight.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

June 27th, 1885.

Prof. GUTHRIE, President, in the Chair.

DR. RAMSAY, Messrs. T. Hands, F. W. Sanderson, W. A. Shenstone, and F. H. Nalder were elected Members of the Society.

The following communications were read —

"On the Specific Refraction and Dispersion of the Alums." By Dr. J. H. GLADSTONE.

The refraction, dispersion, and specific gravity of nineteen different alums in the crystalline form were published by M. Charles Soret, of Geneva, in the *Comptes Rendus* for last November. These, together with some additional data from Soret, Topsøe, and Christiansen, were employed by the author for comparison with certain experimental results of his own and of Kannonikof. In this way additional proof was obtained that a salt has the same specific refraction whether it be crystallised or dissolved, and that the refraction equivalent of a compound body is the sum of the refraction equivalents of its components. The refraction equivalents of the alkalis in these alums are in the following ascending order:—Sodium, potassium, ammonium, rubidium, methylamine, caesium, and thallium; and of the other metals, aluminium, chromium, and iron. This is in accordance with what was previously known, but Soret's observations do not afford the means of determining the equivalents more accurately than before. The refraction equivalents of indium and gallium were determined for the first time, giving respectively 17.4 and 14.8. The specific dispersion of the same compounds, measured by the difference between the specific refractions for the lines A and G, was also examined. The differences of dispersion are much greater comparatively than the differences of refraction. The order was also determined, but not the actual dispersion equivalents of the different elements.

"On a Form of Standard Daniell Cell, and its Application for Measuring Large Currents." By Dr. J. A. FLEMING.

The author first referred to the careful and thorough investigation of the circumstances affecting the electromotive force of Daniell's and allied cells by Dr. Alder Wright. He then described a form of cell that had been found most convenient and reliable in practice. It consists of a U-tube, in the two limbs of which are the two solutions of sulphate of copper and sulphate of zinc of the same specific gravity. Electrodes consisting of freshly electro-deposited copper and pure zinc that has been twice distilled dip into the two limbs. The E.M.F. of this cell is 1.102, and the variation of E.M.F. with temperature is practically nil.

"On the Phenomenon of Molecular Radiation in Incandescent Lamps." By Dr. J. A. FLEMING.

Some years ago Dr. Fleming had called attention to a phenomenon in incandescent lamps very analogous to that of discharge in high vacua observed by Mr. Crookes. The inner surface of the lamp-glass was sometimes found to be coated with a deposit of carbon, with the exception of a clear line marking the intersection of the glass with the plane of the loop, and being, in fact, a shadow of the loop apparently caused by the emission of matter from the terminals. Dr. Fleming has since found how to produce this appearance at pleasure by passing a very strong current momentarily through a lamp, and has succeeded in obtaining similar deposits of various metals that had been used as terminals. These deposits show colours by transmitted light, and as a general result the author concludes that red metals, such as gold and copper, appear green by

transmitted light, whereas white metals—like silver and platinum—appear brown, a conclusion which, however, was challenged by Captain Abney in the discussion ensuing.

"On Problems in Networks of Conductors." By Dr. J. A. FLEMING.

"Lecture Experiments on Colour Mixtures." By Capt. ABNEY.

The apparatus employed by Capt. Abney is a modification of Maxwell's colour-box; the spectrum, instead of being formed upon a screen, is received upon a convex lens, which forms an image of the face of the prism upon a screen. If all the light from the prism falls upon the lens this image is colourless, but by interposing a screen with a slit in the spectrum close to the lens so as only to allow light of a given colour to fall on the lens, the image appears coloured with that light. By using two or more slits different lights may be mixed in any required proportions.

"On Stream-lines of Moving Vortex-rings." By Prof. O. J. LODGE.

The communication described a method of drawing vortex stream-lines, consisting in superposing uniform motion represented by a series of parallel lines upon the lines of a stationary vortex, as given by Sir W. Thomson in his memoir on vortex motion, and joining up the corners of the quadrangles so formed. This operation is very simple, and by its application a number of the more remarkable properties of vortex-rings may be obtained, the general analytical investigation of which involves mathematical methods of the highest order. Drawings were exhibited showing the nature and behaviour of a single vortex ring moving with different velocities, a vortex ring approaching a large distant obstacle, the chase of two unequal rings, and many other cases.

"On the Thermo-electric Position of Carbon." By I. BUCHANAN.

It having been observed that the carbon filaments of incandescent lamps usually gave way at the negative end, experiments were instituted to find if the destruction could be due to the "Peltier effect" causing a local generation of heat. Observations on a platinum-carbon thermo-couple showed that a generation of heat would result from a current passing from carbon to platinum, but the effect was too small to account for the observed phenomenon. It was found that a couple of carbon-iron rose considerably in E.M.F. by maintaining the hot joint for some time at 250° C.

"On some Further Experiments with Sulphur Cells." By SHELFORD BIDWELL.

The paper contains (1) a description of a class of cells which give a constant voltaic current, the electrolyte consisting of a solid metallic sulphide; (2) an explanation of the unilateral conductivity exhibited by selenium and by sulphur cells; and (3) a description of a cell which gives, as the result of passing a current through it, a current in the same direction as the primary current.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, July 6, 1885.

WILLIAM HUGGINS, Esq., D.C.L., F.R.S.,
Manager and Vice-President, in the Chair.

Sir Isaac Lowthian Bell, Bart., F.R.S., F.C.S., M.I.C.E., Edwin Drew, M.D., B.Sc., and John Montague Spencer Stanhope, Esq., J.P., were elected Members of the Royal Institution.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

A Chapter of Psycho-Physiology. (Un Capitolo di Psico-fisiologia.) *Giordano Bruno.* Lectures by ENRICO DAL POZZO DI MOMBELLO. Foligno: Pietro Scariglia. PERHAPS at first glance the reader may suppose that the two subjects of these lectures are presented as intimately connected. It is not so. The eloquent and learned eulogium on Giordano Bruno which concludes the volume has no further relation with the lectures on psycho-physiology than that all have alike been delivered by the same author. From an analysis of his works the author shows that Bruno was an evolutionist. Evolution he regards as the old Aryan doctrine, whilst the opposing hypothesis of individual creation from without he pronounces to be of Semitic origin. Incidentally he vindicates the Arabs from the false charge of having destroyed the Alexandrian Library, proving that this deplorable piece of mischief was committed long prior to the days of the Caliph Omar, and that the perpetrator was the Bishop Theophilus, of Antioch.

The psycho-physiological portion of the work consists of seven lectures devoted in succession to preliminary considerations, to hypnotism, suggestion, animal magnetism, somnambulism, human radiation, and psychism.

In the fifth of these lectures there is a very full account of the double personality of Felida X., as given by Dr. Azam, of Bordeaux. The seventh chapter describes, in connection with psychic forces, the experiments of Mr. W. Crookes and his consequent controversies with Dr. Carpenter.

An analysis of the conclusions arrived at in these chapters would require more space than can be accorded to a subject so different from those to which the CHEMICAL NEWS is devoted.

Professor di Mombello's work will be read with much interest by all students of mesmerism and kindred subjects.

CORRESPONDENCE.

CALCULATION OF CHEMICAL EQUATIONS.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. li., p. 265, Mr. Madan has given a method for calculating the coefficients in chemical equations. Such a method has been used by me for some time; it was first published in the *Proceedings of the Manchester Literary and Philosophical Society*, vol. xvii. (Session 1877-78), and subsequently reprinted in your journal. I gave the method in a general form and some applications of it, viz., to the production of nitric oxide from copper and nitric acid, also to the production of carbonic acid by Fownes' process. This method of determining the coefficients has, I think, not yet found its place in any English text-book of chemistry, and is, I think, but little known.—I am, &c.,

JAMES BOTTOMLEY.

Lower Broughton Rd., near Manchester.
July 3, 1885.

CAMPBOR MOTIONS.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. li., p. 277, I find a paper by Mr. Thomas Hart on "Camphor Motions," in which occurs the following:—

"The reasons assigned to the motions of camphor by Mr. Casamajor, in a paper in the CHEMICAL NEWS (vol. li., p. 109), appeared to me (Mr. Hart) quite inadequate.

The author of the paper . . . attributed the cause to two separate facts:—

"1. That the specific gravity of camphor is lower than that of water.

"2. That camphor is perceptibly soluble in water."

Mr. Hart then proceeds to dispose of the "cause as attributed to these two separate facts" in the following manner:—

"It will be necessary simply to state (1) that there are numbers of other materials lighter than water, and (2) that no less than 1000 parts of water are required to dissolve 1 part of camphor."

In reply to the above I beg leave to say that I did not "attribute the cause of camphor motions to two separate facts." What I did say was this:—

"I think that a connection exists between camphor motions and the three following facts:—1st, that camphor dissolves in water quite easily at times; 2nd, that its density allows it to float on water; and, 3rd, that the solution has a density slightly different from that of water."

If I had thought that these facts have a direct connection of cause and effect to camphor motions I would have stated as much. I had not facts to establish what the connection was, so that I added immediately after:—"I am not prepared at present to develop these ideas, which would require further experiments to establish."

I did not pretend to say what the cause of camphor motions is, and I have no objection to Mr. Hart or anyone else offering any hypothesis which may seem to him rational. I have, however, very serious objections to Mr. Hart or anyone else making inaccurate statements as to what I actually said.—I am, &c.,

P. CASAMAJOR.

Brooklyn, June 25, 1885.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. c., No. 22, June 2, 1885.

Measurement of the Magnetic Rotatory Power of Bodies in Absolute Units.—The theorem upon which this method of observation is founded is as follows:—"If we consider a bobbin comprising N folds of wire traversed by an electric current of the intensity I , the integral of the total magnetic field following the axis of the bobbin supposed to be indefinitely prolonged in both directions is independent of the dimensions of the bobbin and is equal to $4\pi NI$."

Spectroscopy by means of Radiant Matter.—W. Crookes.—When the spark of an induction coil traverses a tube fitted with aluminium electrodes the appearances vary according to the degree of exhaustion to which the gas contained in the tube has been brought. At about a pressure of one-millionth of an atmosphere the molecular discharge which emanates from the negative pole begins to render the glass phosphorescent at the point of impact. Under the influence of this kind of electric discharge, which the author terms radiant matter, many substances emit a phosphorescent light. On examining this light with the spectroscope the spectrum of phosphorescence is sometimes, though rarely, found to be discontinuous. This new spectroscopic method, by radiant matter, not merely gives an indication of the almost constant presence of yttrium in a great number of minerals; it reveals the existence of another element characterised by a broad red band, a double orange band, and a green band. This element is identical with the samarium of M. Lecoq de Boisbaudran.

Presence of Sulphurous Acid in the Atmosphere of Towns.—G. Witz.—Facts with which everyone in England is familiar, and which are forcing themselves into notice in France as the consumption of coal increases. The most novel point in this paper is that the presence of sulphurous acid in the atmosphere of towns occasions a notable decrease of ozone in the atmosphere.

Arsenic in the Soil of Cemeteries, from a Toxicological Point of View.—MM. Schlagdenhauffen and Garnier.—The authors prove that arsenic is disseminated, in variable but often considerable quantities in the soils of the Vosges; the red sandy soils appearing to contain the most. The cemeteries of this region are necessarily laid out on arsenical soils. This arsenic is probably in the state of iron arseniate; it is slightly soluble in boiling water, but it completely resists the action of water at common temperatures. Arsenic in any form left in aqueous solution in contact with an argilo-calcareous and ferruginous soil is gradually converted at common temperatures into insoluble compounds which are retained by the soil. This change is accelerated by the heat of the water-bath. Any arsenical compound, even if very soluble (potassium arseniate), introduced into a natural soil and submitted to the infiltration of rain at different seasons behaves in the same manner. If insoluble, it remains so; if soluble, it gradually becomes insoluble, and so quickly that at depths of 0.60 and 0.90 metre below the place where it has been deposited not a trace can be detected at the end of fourteen months. These results confirm the observations of Orfila in 1847, and prove the impossibility of arsenic being conveyed from the soil into a corpse.

Elective Alcoholic Fermentation.—Em. Bourquelot.—The expression "elective alcoholic fermentation," originated by Dubrunfaut, supposes that yeast, if sown in a medium containing several kinds of fermentible sugars possesses the power of selecting among them the most suitable and of destroying it first. The author finds that elective fermentation may be modified by temperature, by dilution, and by the alcohol formed during fermentation.

Bulletin de la Société Chimique de Paris.
Vol. xliii., No. 8, April 20, 1885.

Reducing Properties of Oxygenated Water.—M. Martinon.—The author studies the behaviour of oxygenated water with manganese peroxide. The decomposition of the hydrogen peroxide is very complete in an acid solution, when there is formed a manganous salt with a rapid escape of oxygen. In a neutral or alkaline medium the manganese peroxide remains unaltered and only 1 atom of oxygen escapes for each mol. of hydrogen peroxide. The author supposes it probable that the manganese peroxide is reduced in either case, but that in an alkaline liquid the manganese monoxide formed returns to the state of dioxide by contact with the oxygen set free. With manganese sesquioxide in an acid liquid there is formed a salt of protoxide, and 2 atoms of oxygen escape. With potassium permanganate in an acid solution all the oxygen of the hydrogen peroxide escapes, and there is formed a manganous salt corresponding to the acid added. This reaction may be utilised for the determination of oxygenated water. We add, drop by drop, to 1 c.c. of the sample to be analysed, diluted with 10 to 15 c.c. of distilled water, and strongly acidulated, a standard solution containing 5.659 of pure permanganate per litre. When the liquid begins to take a rose colour the number of c.c. decolourised indicates the volume of oxygen combined with the water. If, in a neutral or alkaline liquid, we add permanganate to oxygenated water, there is produced at first manganese sesquioxide; then this sesquioxide, in presence of alkaline oxygenated water, passes to the state of peroxide, and induces complete decomposition of the oxygenated water. If the oxygenated water is added to the permanganate there is decomposition, and

formation of a brown precipitate of hydrated sesquioxide. If the solution of permanganate is dilute and alkaline, we observe, on the slow addition of oxygenated water, the formation of green manganate. In an acid solution with lead peroxide there is formed a salt of lead protoxide, and all the oxygen of the hydrogen peroxide escapes. In an alkaline solution only 1 atom escapes, and the lead binioxide remains unaltered. Mercuric oxide is reduced only in an alkaline liquid, with formation of mercurous oxide.

New Researches on the Compounds of Didymium.—P. T. Clève.—This paper will be inserted in full.

Remarks on Certain Criticisms by M. Friedel, with Reference to Chloral Hydrate.—L. Troost.—Already noticed.

On Ammonium Glyoxal-Bisulphite.—M. de Forcrand.—Not susceptible of useful abstraction.

Bromo-Substitution of Phenolic Hydrogen: Bromo-Tribromophenol.—E. Werner.—Phenol may be completely converted into bromo-tribromophenol by dissolving the equivalent of phenol in 60 litres of water, and pouring rapidly into any volume of this solution an equal volume of bromine water containing at least 20 grms. bromine per litre. The mixture is stirred for some moments, let stand until clear, and stirred again, when bromo-tribromophenol is deposited in crystalline scales.

Combustion-Heat of the Coal of Ronchamp.—M. Scheurer-Kestner.—Already noticed.

Russian Correspondence.—Session November 1/13, 1884:—

M. Chalfeef sent in a paper on the preparation of hemine.

M. Lagorio described the crystalline form of Chalfeef's hemine.

M. Godzinsky sent in a new apparatus for the automatic washing of precipitates.

M. Lopatkin sent in a memoir on the reaction of allyl iodide and zinc upon epichlorhydrine.

M. Kanonowitch described his researches on isopropyl-allyl-dimethyl carbinol, and on its methylic ether.

M. Chatzky communicated researches on diallyl-oxalic acid, on its salts, and on certain transformations of this acid.

The same chemist sent in a note on the preparation of the ether of oxalic acid.

M. Lidoff discussed the formation of hydroxylamine on the action of potassium nitrite upon hydrosulphurous acid.

M. Markownikoff described the composition of astrakanite, a mineral found in one of the salt lakes on the northern borders of the Caspian.

Madame Miropolsky announced that the sulphuric acid of commerce, and even the fuming acid, often contain traces of mercury which cannot be removed by distillation. Its presence may be detected by passing an electric current through the dilute acid, using a gold needle as negative electrode. After electrolysis the needle is washed in water, alcohol, and ether, dried, and placed in a sealed tube, the upper end of which is capillary. After heating the lower end characteristic drops of mercury may be recognised with the microscope in the capillary extremity.

Vol. xliii., No. 9, May 5, 1885.

Electro-pseudolysis.—Dr. D. Tommasi.—Already noticed.

Action of Oxidising Agents upon Chloral Hydrate.—S. Cotton.—The author has studied the action of yellow and red mercury oxides, potassium permanganate, and chromic acid. Both the mercury oxides effect the decomposition of chloral hydrate in an aqueous solution. In both cases there is given off a mixture of carbon monoxide and dioxide. But the red oxide, whether obtained in the moist or the dry way, is much less active than the yellow modi-

fication. Its action begins only at 100° , and it undergoes no modification, whilst the yellow oxide begins to react at 85° , and it is chiefly converted into mercury oxychloride. Potassium permanganate sets up a most complex reaction. Chlorine, carbon dioxide, oxygen, and chlorine are given off. The action begins in the cold. Deliquesced chromic acid poured upon crystallised chloral hydrate attacks it violently with evolution of carbon dioxide and monoxide. In a dilute solution, chromic acid has no action in the cold, but with the aid of heat action begins, and the products are the same as those with the concentrated acid.

Biedermann's Central Blatt fur Agrikultur Chemie.
Vol. xiii., Part 12.

The Variation of Atmospheric Precipitation.—W. Kremser.—The mean values of the various meteorological factors at any place give us evidently no correct image of its climatic relations. The frequency and the magnitude of the deviations of the single elements from their mean values characterise the climate. The mean variability of downfall increases as the latitude diminishes. The variability in districts which lie on the sheltered side of a mountain chain is considerable. It is smaller on extensive low plains and on table-lands. In Germany and Upper Italy the greatest fluctuation falls in the winter and the smallest in the summer.

A Filter for removing Microbia from Water.—C. Chamberland.—Noticed under *Comptes Rendus*.

The Inundations of the Durance.—M. Dieulafoy.—From the *Comptes Rendus*.

Activity of the Lower Organisms in Arable Soil.—E. Wollny.—An account of the results obtained by Schlösing, Muntz, Gilbert, Warington, &c. These researches, the author considers, place it beyond all doubt that the changes which the humous matter of soils undergoes are almost exclusively connected with the vital activity of microbia.

On Ensilage.—Cattle foods preserved in silos lose a large proportion of their albumenoid constituents,—in some instances as much as 60 per cent. Part of the nitrogen escapes, whilst a portion appears in the form of amides.

The Source of the Nitrogen in Plants.—Sir J. B. Lawes.—This memoir, which appeared first in the *Annales de Chimie et de Physique*, is a summary of the latest results obtained at Rothamsted. Whilst the atmosphere is the main, if not the exclusive, source of carbon for our crops, the soil is the principal, if not the exclusive source of nitrogen. The author is of opinion that arable soil loses as much, or more, nitrogen in the form of drainage as it receives from the atmosphere.

Cosmos les Mondes.
No. 17, May 25, 1885.

Artificial Truffles.—These questionable delicacies are said to be made of potatoes, coloured by exposure to the air of cess-pools and flavoured with a few drops of phenol!

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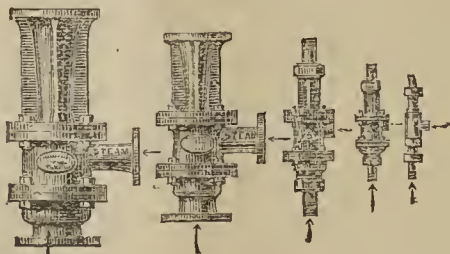
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THE CHEMICAL NEWS.

VOL. LII. No. 1338.

THE REMOVAL OF MICRO-ORGANISMS FROM WATER.*

By PERCY F. FRANKLAND, Ph D., B.Sc., F.C.S.,
Assoc. R. Sch. Mines, Demonstrator of Chemistry in the Normal
School of Science, South Kensington Museum.

THE overwhelming evidence which has been now accumulated of the fact that some at least of the diseases called "zymotic" are propagated by means of living organisms renders it interesting to discover in what manner such organisms may be removed from the media—air and water—through which they are in general distributed. In the following pages I have the honour to bring before the Royal Society the results of some experiments upon which I have been recently engaged, with a view to discover whether and to what extent micro-organisms may be removed from water by submitting this medium to some of the various processes of treatment which are in vogue for its purification. For although the chemical efficiency of numerous methods of water-purification has been largely studied, little has been done in the matter of determining their value as agents for the removal of micro-organisms.

The method of investigation which I have adopted was to take water in which the number of organisms was approximately known, submit this to treatment in such a manner as not to introduce extraneous organisms during the experiment, and then determine the number of organisms which remained in a given volume of the water after treatment. Since we are doubtless at present only acquainted with a few of the micro organisms which are capable of producing disease, it appeared to me to be, in the first instance, desirable to study the question irrespectively of the nature of the organisms, and only to take into consideration their aggregate number before and after treatment. Moreover, the employment of specific organisms would in all cases have greatly enhanced the difficulty of the experiments, and would in some cases have actually rendered them impossible.

The organisms generally used in these experiments were those which develop in diluted urine after exposure to the air. The solution was further diluted more or less with water so as to obtain a liquid containing a convenient number of organisms in a given volume.

The method of determining the number of organisms present in the waters, both before and after treatment, was, with a few modifications, that devised by Koch, in which a definite volume of water is mixed with sterilised nutritive gelatin, and then poured out upon a glass plate, when, after the lapse of a few days, the colonies derived from the individual centres of life can be counted by means of a lens, and from this the number present in a cubic centimetre or any other volume of water can be calculated. The following is a description of the exact mode of procedure adopted:—

Determination of the Number of Micro-Organisms in Water.

The nutritive gelatin was prepared thus:—1 lb. of lean meat is finely minced, and then infused with $\frac{1}{2}$ litre of water for 1 to two hours, the solid part being then strained off through linen; 100 grms. of white French gelatin is allowed to soak in another $\frac{1}{2}$ litre of water, and to this the extract of meat obtained above is added. The whole is

now boiled for a few minutes to complete the solution; 10 grms. of peptone and 1 $\frac{1}{2}$ gm. of common salt are then added and dissolved. The mixture so obtained gives an acid reaction, which is carefully neutralised with carbonate of soda. The liquid is now clarified by beating in the contents of two or three eggs along with the broken shells, the whole being briskly boiled for a few minutes. The coagulated albumen rises to the surface and carries with it the other solid particles in the liquid. On then straining through linen an almost clear liquid is obtained, which is finally clarified by passing through filter-paper kept hot by means of a water-jacket. On cooling this liquid it sets to a yellowish brown transparent jelly. Whilst still liquid it is poured into clean test-tubes, so that each of these contains 2 or 3 c.c. The test-tubes are tightly plugged with cotton wool, and then sterilised by steaming them for half an hour, on three consecutive days. Tubes thus prepared were found to keep for an indefinite period of time. The glass plates destined to receive the film of gelatin were well washed, and then placed in a copper box provided with a tightly fitting lid, the whole being sterilised by heating for at least three hours to 150° C.

The glass dishes in which the gelatin plates are placed during the development of the organisms were always well washed, and then rinsed with a 2 per cent solution of mercuric chloride immediately before use. Some of the same solution of mercuric chloride was poured into the bottom dish, so as to preserve the internal atmosphere saturated with moisture, and the two dishes were always placed in a porcelain tray containing a solution of mercuric chloride, so that the interior of the dishes was disconnected from the outside air by means of a mercuric chloride seal, whereby all ingress of organisms from the atmosphere was prevented during incubation. The dishes also contained a small glass tripod, bearing a glass plate, the surface of which was carefully levelled by placing the dishes on a table provided with three screws. When the apparatus is thus prepared, the sterilised plate is rapidly transferred to the levelled plate, the gelatin is carefully melted in its test-tube, and before removing the cotton wool-plug the latter is burnt outside, so as to destroy any organisms that may be adhering to the exterior. A given number of drops of the water or other liquid under examination are now introduced into the open test-tube by means of a pipette, which has been previously sterilised by heating it nearly to redness in a Bunsen flame. The water and liquid gelatin are mixed by agitation, and then quickly poured out on to the sterilised plate, the glass cover being immediately replaced. The whole operation is so managed that the time of exposure to the air is reduced to a minimum. A solution of mercuric chloride is then poured into the porcelain tray as already described, and when the gelatin has set, which generally takes place in about ten minutes, the dishes are placed in a cupboard, and maintained at a temperature of 20° to 25° C.

After a period of incubation, varying from three to six days, the organisms make their appearance in isolated colonies, which may be readily counted with the assistance of a lens. The operation of counting is greatly facilitated by placing the plate on a black ground, ruled in squares.

That, when due precautions are taken in the execution of this process, little or no appreciable error is introduced by the unavoidable but momentary contact of the gelatin with the air, was proved by making blank experiments, in which all the above-mentioned operations, excepting the addition of water, were performed, and in these cases no organisms were found. Additional proof of this is also furnished by the fact that on several occasions no organisms were found in the course of the experiments to be described below.

The experiments were in nearly all cases made in duplicate, the concordance in the results of parallel experiments being, on the whole, very satisfactory; occasionally, however, wide discrepancies did occur, but these could in most cases be accounted for through the water under

* A Paper read before the Royal Society, June 18, 1885.

examination not having been rendered sufficiently homogeneous by agitation.

Experiments on the Filtering Power of Different Substances.

The substances selected for experiment were natural greensand, silver sand, powdered glass, brickdust, coke, animal charcoal, and spongy iron.

These substances were all obtained in a fine state of division by powdering them in a mortar, and then passing them through a sieve (40 meshes to the inch). The filters were constructed of pieces of glass tubing (1 inch diameter), drawn off at one extremity to a small aperture; the latter was plugged with a small quantity of asbestos, and upon this was placed a column 6 inches in height of the closely-packed filtering material, the surface of which was again protected by a thin layer of asbestos. Before use, the filter thus prepared was sterilised by heating it to a temperature above 150° C. for at least three hours. After sterilisation the filter was at once put in operation by supplying the infected water at the wide end of the tube, the filtered water being collected when required in a vessel sterilised in the same way beneath the lower extremity of the tube. In those experiments in which the filtration was carried on for many days, or even weeks, the infected water was constantly supplied to the filter by means of an inverted flask fitted with a delivery-tube, the latter dipping into the water above the filtering material. The following results were obtained with the various materials:—

Greensand.—The urinous water passed through this filter, on starting, at the rate of 2.07 inches per hour. The sand was highly ferruginous, and the filtered water contained a noticeable proportion of iron.

On examining the unfiltered water it was found to contain 64 centres of life in one, and 97 centres per c.c. in a duplicate experiment; these consisted almost wholly of organisms causing liquefaction of gelatin, a few fungi, and the remainder small spherical colonies. In the filtered water, on the other hand, there were no organisms of any description discoverable. *The filtration had thus completely sterilised the water.*

In order to ascertain whether the greensand would continue to exercise this influence, the arrangement for continuous filtration, as already described, was put in operation, and after being in action for thirteen days—during which time 7.1 litres of water passed through—the efficiency of the filter was again tested. The *unfiltered* urine-water was found to contain 8193 centres per c.c. The *filtered* water was found to contain 1071 centres per c.c. These experiments show that although the original power of the greensand was broken down, the filter was still arresting a considerable proportion of the organisms present in the water passing through it.

The efficiency of the filter was again determined after the continuous filtration had proceeded for one month, when 20 litres of water had passed through. The following results were obtained:—

Unfiltered water contained .. 1281 centres per c.c.
Filtered " " .. 779 " "

On the whole, therefore, even after the lapse of an entire month, a notable proportion of the organisms was still being removed by the greensand filter.

Animal Charcoal.—Perfectly similar experiments were made with this well-known filtering material. On examining the initial efficiency of the filter, it was found that whereas the *unfiltered* water contained so many organisms that the gelatin on the plates had become entirely liquefied, the *filtered* water did not contain in either of two experiments any organism whatever. The filter had thus completely sterilised the water passing through it.

The rate of filtration was considerably less rapid than in the case of the greensand, being only 0.82 inch per hour. Continuous filtration was then carried on for twelve days, during which time 4.2 litres of water passed

through, after which the unfiltered and filtered waters were again examined.

Unfiltered water contained .. 2792 centres per c.c.
Filtered " " .. No organisms of any kind.

Thus the efficacy of the filter remained unimpaired after twelve days' continuous action.

After acting for one month, 14.6 litres of water having passed through, the waters were again examined.

Unfiltered water contained .. 1281 centres per c.c.
Filtered " " .. 6958 " "

Thus at the end of one month the filter was actually delivering water more highly impregnated with organic life than that with which it was supplied.

Spongy Iron.—The filtering power of this material was also examined by means of a similar series of experiments. The rate of filtration at the commencement was 1.84 inches per hour, and the following results were obtained:—

Unfiltered water contained .. 80 centres per c.c.
Filtered " " .. No organisms whatever.

After twelve days' continuous filtration, 3.6 litres of water having passed through, the following results were obtained:—

Unfiltered water contained .. 2792 centres per c.c.
Filtered " " .. No organisms whatever.

Again, at the close of one month's continuous filtration, 9 litres of water having passed through, the examination was repeated:—

Unfiltered water contained .. 1281 centres per c.c.
Filtered " " .. 2 " "

The column of spongy iron, 6 inches in depth, was thus able to remove all the organisms from the water for upwards of twelve days, and even at the end of the month the water, after filtration, was almost destitute of organic life. The rate of filtration was, however, greatly diminished in the course of the month during which the filter was in operation. It is worthy of notice that the organisms found in the filtered water were all of the same kind, and caused no liquefaction of the gelatin, whilst a number of those in the unfiltered water produced liquefaction of this medium.

Brickdust.—The following results were obtained with a filter constructed similarly to the above, and charged with pulverised red brick, the powder being passed through the before-mentioned sieve.

Initial Efficiency.

Unfiltered water contained .. 3112 centres per c.c.
Filtered " " .. 732 " "

After being in action for five weeks, during which time 12.75 litres of water passed through the filter—

Unfiltered water contained .. 5937 centres per c.c.
Filtered " " .. 406 " "

This material, therefore, does not wholly remove the organisms, even when fresh, but it continues, even after five weeks, to remove a considerable proportion of them.

Coke.—With this material, which was also used in the same state of division, the following results were obtained:—

Initial Efficiency.

Unfiltered water contained .. 3112 centres per c.c.
Filtered " " .. No organisms whatever.

After being in action for five weeks, when 13.25 litres of water had passed through—

Unfiltered water contained .. 5932 centres per c.c.
Filtered " " .. 86 " "

This substance, therefore, possesses filtering powers which are second only to those of spongy iron; at the

outset the result is equally perfect with both, and even at the close of five weeks' continuous work the coke removes a large proportion of the micro-organisms present in the unfiltered water. Moreover, the rate of filtration through coke was considerably greater. In the case of the coke, as in that of the spongy iron, the organisms found in the filtered water, were almost exclusively of one kind, only one colony causing liquefaction, forming an exception.

Silver Sand.—Owing to the highly ferruginous character of the greensand employed in the previous experiments, and bearing in mind the well-known antiseptic properties of salts of iron, it was deemed advisable to investigate the filtering power of sand free from iron. The silver sand employed for this purpose was digested for some days with hydrochloric acid, the latter then carefully washed out, and the filter sterilised as already described. The following results were obtained with this material:—

The rate of filtration was exceedingly rapid, viz., 1 inch in less than two minutes, or more than 30 inches per hour. The number of organisms found in the unfiltered and filtered waters respectively were—

Unfiltered water	11,232 centres per c.c.
Filtered „	1,012 „ „

Thus already at the outset the silver sand filter fails to arrest all the organisms in the water, although it very considerably diminishes their number, even when the rate of filtration is exceedingly rapid.

Powdered Glass.—This material also was employed with a view to determining the value of non-ferruginous siliceous matter. The rate of filtration in this case was also very great, viz., 1 inch in less than eight minutes.

The following results were obtained:—

Unfiltered water	11,232 centres per c.c.
Filtered „	792 „ „

The results obtained with the powdered glass very closely resemble those obtained from the silver sand; but as neither were efficient filters, even at the outset of their action, no further experiments were made with them.

Removal of Micro organisms by Agitation with Finely Divided Solid Matter.

The above experiments show that micro-organisms may be more or less completely removed by mere contact with solid particles, some of which are incapable of exerting any chemical action upon them; it therefore appeared of interest to ascertain whether these organisms may be removed by agitating the water with the same substances, and then allowing them to subside. The experiments undertaken with this object were conducted in the following manner:—

50 c.c. of urine water, in which the number of organisms was determined, were placed in a small accurately stoppered bottle, previously sterilised by being heated to 150° C. for at least three hours. A given weight of the substance was placed in a small test-tube, plugged with cotton-wool, and then sterilised in the same way. The sterilised substance was then transferred to the water in the stoppered bottle, and the latter violently shaken for a definite length of time, after which it was allowed to stand at rest until complete subsidence had taken place. Some of the clear supernatant liquid was then taken out with a pipette, and examined for organisms by means of gelatin cultivation in the manner already described. The substances were in all cases employed in the same state of division as in the filtration experiments.

Spongy Iron.—5 grms. of this substance were shaken up with 50 c.c. of urine-water in one case for one minute, and in another for 15 minutes; in both cases the waters were subsequently allowed to subside for half an hour before examination. The following results were obtained:—

Untreated water	609 centres per c.c.
Treated „ shaken for 1 min.	28 „ „
„ „ „ 15 mins.	63 „ „

Thus the reduction in the number of organisms by agitation is exceedingly marked, and curiously the most favourable result was obtained when the agitation was only continued for a single minute. A pure cultivation was not obtained in the treated water, some colonies producing liquefaction of gelatin, and others not, thus presenting a contrast to the results obtained by filtration through this material.

Chalk.—1 grm. of water was shaken up with 50 c.c. of urine-water for fifteen minutes, and then allowed to subside for five hours. The following results were obtained:—

Untreated water	8325 centres per c.c.
Water after 15 minutes' agitation with chalk . .	274 „ „

A very large reduction indeed in the number of organisms was thus obtained.

Animal Charcoal.—1 grm. of animal charcoal was shaken up with 50 c.c. urine-water for fifteen minutes, and then allowed to subside for nearly five hours. The following results were obtained:—

Untreated water	8325 centres per c.c.
Water after 15 minutes' agitation with animal charcoal	60 „ „

The efficiency of the animal charcoal in this respect is thus very markedly greater than that of chalk.

Coke.—1 grm. of coke was shaken up with 50 c.c. of urine-water, and then allowed to subside for forty-eight hours, as the water did not clear before. The following results were obtained:—

Untreated water	Too numerous to be counted
Water after 15 minutes' agitation with coke . .	No organisms whatever.

It thus appears that simple agitation with coke for fifteen minutes is sufficient to entirely remove all organisms.

China Clay.—1 grm. of this was shaken for fifteen minutes with 50 c.c. of urine-water; subsidence was not complete for five days. On examining the clear water it was found to yield a very large number of organisms indeed, thus showing that prolonged subsidence with finely-divided matter like clay is not conducive to the separation of micro-organisms.

A similar result was obtained with brickdust, which, however, did not take quite so long to subside.

(To be continued.)

ON LAKMOID, LITMUS, PHENOL-PHTHALEIN, AND OTHER INDICATORS.

By ROBERT T. THOMSON.

(Concluded from p. 20.)

XV. Chromate and Bichromate of Potassium and Sodium.

It was found that while the chromates (K_2CrO_4 and Na_2CrO_4) were strongly alkaline, the bichromates of potassium and sodium ($K_2Cr_2O_7$ and $Na_2Cr_2O_7$) were exactly neutral to lakmoid. For these tests the paper requires to be used, and washed with pure water to remove the highly coloured solution which masks the colour. We have thus a method of determining the proportion of normal chromate, or of free chromic acid in bichromates, a direct process for which has not been discovered till now. Of course, all that is necessary is to add standard acid or alkali until the neutral-point is reached with the lakmoid-paper. To test the first-mentioned of these processes, 1.476 grms. of pure potassium bichromate was dissolved, and 0.1947 grm. of potassium chromate added. This mixture would contain 88.35 per cent bichromate and 11.65 per cent chromate of potassium. Two tests consumed respectively 9.9 and 10 c.c. of tenth normal acid, the average of which is equal to 0.1937 grm. K_2CrO_4 , or

showing the mixture to contain 88.41 per cent bichromate and 11.59 per cent chromate of potassium. A bichromate containing 0.3 per cent of chromate is faintly alkaline, but one containing 1 per cent may fairly be described as strongly alkaline.

Experiments were also made with the chromate and bichromate of sodium, and these were found to give similar results to the potassium compound. But it is not necessary to give details of these, nor of the successful tests made to determine free chromic acid in the bichromates of potassium and sodium.

Tests made with litmus-paper, which does not give very decided indications under the circumstances, showed that a mixture containing 80 per cent of normal chromate and 20 per cent bichromate of potassium, was neutral to litmus. This, again, shows a great and decisive difference between that indicator and lakmoid.

XVI. Miscellaneous Compounds.

Ferrous sulphate (FeSO_4), ferrous chloride (FeCl_2), copper sulphate (CuSO_4), copper chloride (CuCl_2), and zinc sulphate (ZnSO_4) are all neutral to lakmoid, while they are more or less acid to litmus, paper.

XVII. Determination of Free Sulphuric, Hydrochloric, and Nitric Acids.

These can be determined with great accuracy in the cold with lakmoid solution by sodium hydrate, or with lakmoid-papers by carbonate of sodium. The papers may especially be used for the determination of free acid in sulphate of ammonium. The commercial salt often contains a little sulphate of iron, which, being neutral to lakmoid, does not affect the result; but being acid to litmus, the whole of the sulphuric acid in that state of combination is determined as free acid when the latter indicator is employed. As will be seen from Section XVI., the blue paper can also be used in the estimation of free sulphuric and hydrochloric acids in presence of ferrous chloride, copper sulphate, and zinc sulphate, for which purpose no other indicator is quite satisfactory.

XVIII. Determination of Free Oxalic Acid.

For each test 0.45 grm. of dry oxalic acid ($\text{H}_2\text{C}_2\text{O}_4$) was employed. After the addition of about 17.5 c.c. of half-normal caustic soda the red lakmoid colour began to purple slightly, and at the same time blue lakmoid-paper showed the solution to be slightly acid, while the reddened paper indicated faint alkalinity. On further addition the purple colour became gradually more pronounced, and when 20 c.c. had been added the full blue colour was developed. At this latter stage the solution was strongly alkaline to red lakmoid-paper, and the alkalinity to the paper had become greater and greater, while the faint acidity soon disappeared, on the addition of soda subsequent to reaching the practically neutral-point just referred to. The solution, so far as the very indefinite end-reaction can show, gives the full amount of oxalic acid present, the soda employed having been standardised with sulphuric acid.

With the papers only 87.5 per cent of the acid is determined, or, to state the result otherwise, a mixture containing 91 parts by weight of normal oxalate of sodium ($\text{Na}_2\text{C}_2\text{O}_4$) and 9 parts of oxalic acid would be neutral. This neutral-point is not by any means sharply defined, but a mixture containing more than the stated proportions of the sodium salt is decidedly alkaline, and the normal oxalate is strongly alkaline to red lakmoid-paper. The conclusion would seem to be that lakmoid cannot be recommended as an indicator in the determination of oxalic acid. These results prove that lakmoid must for this purpose, also, be classed with methyl-orange, and that is entirely different from litmus solution or papers, with either of which the full amount of oxalic acid can be estimated, by titration with soda standardised with sulphuric acid, accompanied by the further distinction of a very well-defined end-reaction.

XIX. Determination of Free Acetic, Tartaric, and Citric Acids.

These three acids show similar phenomena to oxalic acid when estimated by standard soda, with lakmoid as indicator. In each case the end-reaction is so uncertain with the solution as to render it useless, and even with lakmoid-papers the neutral-point is only obscurely indicated. It will be unnecessary to give details of each test, as the descriptions would mainly agree with that given for oxalic acid. As nearly as could be judged, the following results were obtained by titrating with half-normal caustic soda, which had been standardised by sulphuric acid. Lakmoid-papers were used to determine the point of neutrality.

Acetic Acid.—Of this acid 22 per cent was estimated, or a mixture containing 28 per cent of acetate of sodium ($\text{NaC}_2\text{H}_3\text{O}_2$) and 72 per cent of acetic acid ($\text{HC}_2\text{H}_3\text{O}_2$) was found to be neutral.

Tartaric Acid.—70 per cent was determined, and the neutral mixture contained 75 per cent tartrate of sodium ($\text{Na}_2\text{C}_4\text{H}_4\text{O}_6$) and 25 per cent of free tartaric acid ($\text{H}_2\text{C}_4\text{H}_4\text{O}_6$).

Citric Acid.—Of this acid 41 per cent was estimated. The neutral mixture thus contained 49 per cent of citrate of sodium ($\text{Na}_3\text{C}_6\text{H}_5\text{O}_7$) and 51 per cent of citric acid ($\text{H}_3\text{C}_6\text{H}_5\text{O}_7$).

With acetic, tartaric, and citric acids litmus differs essentially from lakmoid, but the latter behaves similarly to methyl-orange. Litmus, especially as paper, works well with tartaric acid, but for acetic and citric acids is rather unsatisfactory. For the two last-mentioned acids phenol-phthalein is the only perfect indicator.

XX. Determination of Free Lactic Acid.

I have not formerly given any results of the titration of lactic acid, but will now record those obtained with the following indicators. For each experiment 0.9 grm. of lactic acid was titrated with half-normal caustic soda, and as that acid is somewhat difficult to obtain pure, the result obtained with litmus was employed as a standard of comparison. Litmus is generally recognised as giving accurate results.

Phenol-phthalein.—When this indicator was employed the end-reaction was exceedingly sharp and delicate, and 20 c.c. of the soda was consumed. This is exactly equal to 0.90 grm. lactic acid.

Rosolic Acid gives also a very good end-reaction, but the yellow colour begins to assume a slight pink tinge before the neutral-point is reached, and therefore this indicator is not quite so delicate as phenol-phthalein, although satisfactory. The results were the same as those obtained with phenol-phthalein.

Phenacetolin.—The yellowish colour began to become pink after 18 c.c. half-normal caustic soda were added, but the full colour was not developed till 19.9 c.c. were run in. Phenacetolin cannot be recommended for this purpose.

Methyl-orange.—After addition of 7 c.c. of the standard soda the colour began to change, but this was not complete till 17.5 c.c. were consumed. This is only equal to 87.5 per cent of the free acid present, and as the end-reaction is so extremely indistinct, methyl-orange must be pronounced useless for the purpose under consideration.

Lakmoid.—After adding 13.5 c.c. of half-normal caustic soda the red lakmoid colour began to purple, and simultaneously blue lakmoid-paper showed slight acidity, and red paper slight alkalinity, just as in the case of the organic acids already referred to. The full blue, however, did not appear till 20 c.c. were consumed. Owing to the very indefinite end-reaction lakmoid solution cannot be used for the estimation of lactic acid. With the lakmoid-papers (although with these also the neutral-point is not very decidedly indicated) 67 per cent of the lactic acid was estimated, and the neutral mixture was composed of 71 per cent of lactate of sodium ($\text{NaC}_3\text{H}_5\text{O}_3$) and 29 per cent of lactic acid ($\text{HC}_3\text{H}_5\text{O}_3$).

Litmus began to show signs of purpling after adding 19.5 c.c. of the caustic soda, but 20 c.c. were required to complete the development of the blue. The final change was very distinct, and the full amount of lactic acid was thus brought out. With litmus papers a very reliable result is obtained, but of course they are not quite so delicate as phenol-phthalein, although in many cases they can be used where the latter cannot. The difference in the indications of lakmoid and litmus should again be noted.

XXI. *Behaviour of Lakmoid, Litmus, and Phenol-phthalein with Sweet and Sour Milk.*

The accurate neutralisation of sour milk is of great importance when fat has to be determined in it, seeing that lactic acid is soluble in ether, while lactates are not. Blue litmus-paper is about as delicate an indicator for the purpose as could be desired; and, further, it has been proved beyond doubt that the same proportion of fat is extracted by ether from a milk which has become sour and is neutralised before analysis as was yielded by the fresh milk.

Fresh cow's milk may be said to be neutral to litmus, at least so far as all practical purposes are concerned. The endless discussion as to its being faintly alkaline or acid is of little moment, but it is probable that fresh milk may show both slight acidity and alkalinity to very delicate blue and red paper, as the point of neutrality is not very definite when phosphates are present. If the reaction of milk towards litmus is uncertain, there is no doubt that it is strongly alkaline to red lakmoid-paper, and acid to phenol-phthalein which has been reddened by a trace of caustic soda. To test the extent of alkalinity and acidity of sweet and sour milk to these three indicators, 10 grms. were operated upon for each experiment. Exactly the same results were obtained when the milk was tested before and after dilution with water.

Lakmoid.—With this indicator, in the form of paper, 10 grms. of the milk consumed 5.9 c.c. of N/10 sulphuric acid, which is equivalent to an alkalinity represented by 0.236 per cent of NaHO. The casein was precipitated during the addition of the acid. Another 10 grms. of the milk was ignited, and the ash (of which the milk contained 0.72 per cent) dissolved in 10 c.c. of N/10 sulphuric acid, by the aid of heat, then cooled, and titrated back with N/10 caustic soda. It was found that the acid neutralised was equal to 0.240 per cent of NaHO (that is, parts per 100 of the milk), or practically the same result as was obtained with the milk itself. This would seem to point to the conclusion that the alkalinity of the milk, so far as lakmoid is concerned, is due simply to that of the mineral constituents. But as we do not know whether the casein or other organic constituents of the milk have any action no reliance must be placed on this view of the matter, as the coincidence may be merely accidental.

The milk after souring for three days was still alkaline, and 10 grms. consumed 1.3 c.c. N/10 sulphuric acid, which is equal to 0.052 per cent NaHO. The end-reaction, as was to be expected in presence of lactic acid, was not so well defined as in sweet milk. Even after standing for three weeks the milk still showed an alkaline reaction to red lakmoid-paper. A sample of milk, however, which had stood for six months, and was thoroughly decomposed, was slightly acid to blue lakmoid-paper.

Litmus.—The milk was practically neutral to litmus-paper, but the ash when treated as in the case of lakmoid, neutralised acid equal to 0.120 per cent of NaHO.

The milk was also tested after three days' souring (the same sample as was used for lakmoid being used for all the tests), and 10 grms. consumed 6.4 c.c. of N/10 NaHO. This is equal to 0.256 per cent of SO₃ or 0.576 of lactic acid.

Phenol-phthalein solution gives a pretty distinct end-reaction with milk, and for 10 grms. 1.5 c.c. of N/10 NaHO were required to bring to the neutral-point. This is equivalent to 0.060 per cent of SO₃. The ash treated as

described before showed an alkalinity of 0.060 per cent of NaHO, so that the ash shows an alkalinity exactly equal in extent to the acidity of the original milk. Lastly, the sour milk gave an acidity equal to 0.320 per cent SO₃, which is higher than that obtained with litmus, to about the same extent as phenol-phthalein gives in fresh milk.

Milk may possibly contain organic constituents which affect litmus and phenol-phthalein and do not affect lakmoid, and hence the difference of reaction shown by the original milk and its mineral constituents when tested with the two former indicators. Or lakmoid may be affected differently from litmus and phenol-phthalein, and thus the results obtained with the first-named indicator would simply be a chance coincidence. But explanations must be left for further investigation.

The results recorded above lead to the conclusion that lakmoid cannot be used in the neutralisation of sour milk previous to the extraction of fat by ether, owing to the fact that it is already alkaline. With phenol-phthalein, on the other hand, more soda is added than with litmus before the neutral-point is reached, and it is probable (but enough has not yet been done to settle this question) that this extra soda may, on subsequent heating, saponify a portion of the fat, and the percentage of the latter might thus come out too low.

The results of the experiments described above are expressed in terms of NaHO and SO₃, for the simple reason that they possess the same equivalent, and are thus strictly comparable.

XXII. *Determination of the Acidity of Urine.*

This is another case in point in which an indiscriminate use of indicators would lead to serious consequences. Litmus is always employed for the determination of free acid in urine, and, as is well known, an average sample of normal urine is acid to that indicator. Urine is also acid to phenol-phthalein, but to lakmoid is strongly alkaline. This difference in indication shown by litmus and lakmoid is without doubt partly due to their different behaviour with the various phosphates present in urine, but this cannot account for the whole difference. The weak organic acids, urea, and other organic constituents must also have some action.

Litmus.—To 50 c.c. of a sample of urine N/10 caustic soda was added, and 8.3 c.c. were required to render that quantity neutral to litmus-paper. This is equal to 0.66 gm. of SO₃ per litre. I have adopted SO₃ and NaHO as convenient standards of comparison, although the free acid is more often calculated as oxalic acid.

Phenol-phthalein.—Solution was used, and 17 c.c. of the tenth-normal caustic soda was consumed, which give an acidity represented by 1.36 grms. of SO₃ per litre. The end-reaction is very indistinct, and for that reason the use of phenol-phthalein cannot be recommended.

Lakmoid.—With this indicator in the form of paper 11 c.c. of N/10 sulphuric acid were consumed by 50 c.c. of the urine before the neutral-point was reached. This result is equivalent to 0.88 gm. of NaHO per litre, or the alkalinity of urine towards lakmoid is much greater than its acidity to litmus. The latter is still our best indicator for use in the determination of the acidity in urine, and lakmoid above all cannot be employed as a substitute.

XXIII. *Effect of Alcohol on the Delicacy of Indicators.*

Litmus and Lakmoid.—It cannot fail to have been observed that the delicacy of blue litmus-paper for the detection of free acid in strong alcohol is much less than in aqueous solution, and this is no less true of blue lakmoid-paper. A piece of the latter was placed in 100 c.c. of absolute alcohol, and 0.2 c.c. of normal acid added, a quantity which, if mixed with 100 c.c. water, would give an almost instantaneous acid reaction. It was several minutes before even the slightest reddening was observed, and litmus-paper was not much more sensitive. When the alcohol is diluted with about twice its volume of water the delicacy of the paper is very little

Lakmoid-paper.		Litmus-paper.	
NaHSO ₃ *		{ Na ₂ SO ₃ 85 %	
		{ NaHSO ₃ 15 %	
NaH ₂ PO ₄ *		{ Na ₂ HPO ₄ 88 %	
		{ NaH ₂ PO ₄ 12 %	
K ₂ Cr ₂ O ₇ *		{ K ₂ CrO ₄ 80 %	
		{ K ₂ Cr ₂ O ₇ 20 %	
{ Na ₂ C ₂ O ₄ 91 %		Na ₂ C ₂ O ₄ *	
{ H ₂ C ₂ O ₄ 9 %			
{ NaC ₂ H ₃ O ₂ 28 %		{ NaC ₂ H ₃ O ₂ 99·8 %	
{ HC ₂ H ₃ O ₂ 72 %		{ HC ₂ H ₃ O ₂ 0·2 %	
{ Na ₂ C ₄ H ₄ O ₆ 75 %		Na ₂ C ₄ H ₄ O ₆ *	
{ H ₂ C ₄ H ₄ O ₆ 25 %			
{ Na ₃ C ₆ H ₅ O ₇ 49 %		{ Na ₃ C ₆ H ₅ O ₇ 99 %	
{ H ₃ C ₆ H ₅ O ₇ 51 %		{ H ₃ C ₆ H ₅ O ₇ 1 %	
{ NaC ₃ H ₅ O ₃ 71 %		NaC ₃ H ₅ O ₃ *	
{ HC ₃ H ₅ O ₃ 29 %			

affected. The best method to apply blue lakmoid-paper in alcoholic solutions is, after holding for a short time in the fluid, to evaporate off the alcohol from the paper by a gentle heat, when the acid reaction will quickly appear. Red lakmoid-paper shows almost immediately even a slight alkalinity in the strongest alcohol, and if the latter, containing a trace of alkali, be coloured blue with lakmoid solution, one drop of normal acid will change the colour instantaneously.

Methyl-orange.—When coloured with this indicator 100 c.c. of absolute alcohol requires at least 0·5 c.c. of normal acid to effect even a slight change in colour, and several c.c. are required to bring about the full change. The end-reaction is so indistinct that no definite result can be given. When diluted with about five or six times its volume of water alcohol has little effect on methyl-orange, and its influence when thus diluted may be disregarded.

Solutions of phenol-phthalein, phenacetolin, and rosolic acid are nearly, or quite, as delicate in strong alcoholic as in aqueous solutions.

XXIV. Notes.

(1) Phenol is neutral to lakmoid, and in this respect agrees with methyl-orange, litmus, phenacetolin, and rosolic acid; while to phenol-phthalein, as I formerly showed, it is distinctly acid, although the end-reaction is unreliable.

(2) Saliva is invariably strongly alkaline to red lakmoid-paper. To litmus, as is well known, saliva is generally slightly alkaline, although it is sometimes faintly acid.

(3) It is best to use lakmoid-papers in cold solutions, as I have invariably done in the experiments quoted in the above paper. As was before stated, no danger of a false indication may be apprehended from the presence of carbonic acid, for though that acid may slightly purple blue lakmoid-paper, the blue returns on exposure to the air for a few seconds.

I think the statement that lakmoid closely resembles litmus in its properties as an indicator is now fully proved to be very far from the truth, except in very limited circumstances. It is really desirable that chemists should be a little more careful of rushing into print with assertions which cannot bear for a moment the test of experiment.

The table above gives a comparative view of a few of the salts, or the percentage composition of mixtures of salts and acids, neutral to lakmoid and litmus respectively. In comparing the results obtained with litmus-paper with some of those in my former table with litmus solution, it will be found that they do not agree. This is due to the fact that in titrating with acid when the solution was employed as indicator, the acid was added until the full change in colour was brought out, and this by no means agrees with the indication shown by litmus-paper. The latter gives much better end-reactions than the solution in all cases recorded in the table above, and, indeed, the

solution is useless for some of them. Those of which the end-reactions are delicate, or at least satisfactory, are marked with a *, while the others are more or less unsatisfactory in this respect. Normal sulphuric acid was used in the experiments required to establish the results given in the table, and the caustic soda was standardised with the sulphuric acid. Had the soda been standardised with acetic acid, for instance, lakmoid being used as indicator, the results would necessarily be different.

I intend still further to investigate the behaviour of indicators with other chemical compounds, and also to make a more extended examination of the results obtained in titrating milk, &c.

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LIMONITE.

By J. CUTHBERT WELCH.

DURING the autumn of 1884 a specimen of iron ore was given to me by a friend as being limonite, from Carrock Fell, in Cumberland. Its appearance seemed to me very unlike the usual forms of limonite, and I thought of submitting it to analysis on some future occasion. That time has now arrived, and it is this specimen which forms the subject of these lines. The structure of it was remarkable, for, instead of being compact and stony, or granular and crumbling, as is usually the case with this ore, it consisted of small roundish particles, slightly flattened upon two opposite sides, set in a ground mass of what appeared to be red sandstone. The size of these particles varies from that of a pin's-head, with a diameter of one-sixteenth of an inch, to that of a pea, with a diameter of one-quarter of an inch; and their specific gravity, when separated from adhering portions of the matrix, was 2·975.

The colour was brownish red of a peculiar shade, with a good, and almost metallic, lustre. This colour once more reminded me of a question that has long puzzled me, namely, What is the variation in the colour of limonite due to? Why is one specimen brownish yellow, another brownish red, and another brownish grey? The only manner in which I can account for it is in the quantity of admixed silica, for of course silica, beyond an inevitable trace, is not a necessary component of this mineral. It would appear that the less the quantity of silica the darker and greyer is the ore, whilst as the proportion increases so does the ore become lighter and browner in colour, until at last it becomes almost yellow. This surely would be the tendency of the admixture of light-coloured silica with dark-coloured limonite. Sufficient proof of this is given, I think, in the fact that the particles of ore appear to be much lighter in colour when set in the lighter coloured matrix than they do when removed from it; and, again, in the two specimens I possess the colour is dark grey, the percentage of silica being respectively 5·37 and 2·139, whilst in this light one the silica will be seen to be 46·56 per cent, and in several other specimens I have tested the silica has varied between these two extremes, the less the silica the lighter being the colour. This question of colour-shades is interesting. The only explanation I have yet heard offered was suggested by a friend, it being that it depends upon the state of hydration of the oxide. This theory appears to me to be untenable; for specimens varying but little, if any, in the percentage of combined water as compared with the percentage of ferric oxide, but varying in the proportion of silica they contain, often differ much in colour.

The data of the analysis are as follow:—

Moisture.—5 grms. lost 0·1605 grm. at 100° C.

Combined Water.—1 grm. of the dried mineral lost 0·13 grm. on ignition.

Silica.—5 grms. yielded 2·328 grms. of silica.

Ferric Oxide.—1 grm., after solution in hydrochloric acid and reduction with zinc, required 22·8 c.c. of

potassium bichromate solution, where 1 c.c. = 0.01 of Fe.

Phosphoric Acid.—1 grm., done by a combination of the molybdic acid and magnesia methods, yielded 0.024 grm. of magnesium pyro-phosphate.

Alumina.—5 grms. gave 1.7761 grms. of mixed ferric oxide and alumina. From this percentage the ferric oxide calculated by the volumetric method was deducted, thus giving alumina by difference.

Lime.—5 grms. yielded, on ignition of the calcium oxalate, 0.079 grm. of lime.

Magnesia.—5 grms. yielded 0.031 grm. of magnesium pyrophosphate.

Ferrous Oxide and Sulphur.—Both absent.

Manganese Protoxide.—Trace was perceived, but was unweighable even on 10 grms. of ore.

	Original Mineral.	Mineral dried at 100° C.
Moisture	3.2000	—
Combined water.. ..	12.5840	13.0000
SiO ₂	46.5600	48.0992
Fe ₂ O ₃	32.5714	33.6481
P ₂ O ₅	0.3070	0.3171
Al ₂ O ₃	2.9507	3.0482
CaO	1.5200	1.5702
MgO	0.2234	0.2308
FeO	absent	absent
S		
MnO		
	trace	trace
Total	99.9165	99.9136

If the ferric oxide and combined water be calculated to percentages, regarding all else as impurities, we obtain—

Fe ₂ O ₃	72.13
H ₂ O	27.87
	100.00

This gives the formula Fe₂O₃.3½H₂O.

If, however, we calculate the ferric oxide and combined water to percentages, allowing the alumina to have replaced ferric oxide, and regarding other matters as impurity, we obtain—

Fe ₂ O ₃	73.84
H ₂ O	26.16
	100.00

This gives the formula Fe₂O₃.3H₂O, which, in theory, would require—

Fe ₂ O ₃	74.76
H ₂ O	25.24
	100.00

Hence we see that the ore is a limonite of good composition, but rendered impure by the large admixture of silica.

The ground-mass varies but little in composition. In three determinations of silica from various portions, 5 grms. gave variously 3.207 grms., 3.0621 grms., and 2.9708 grms. of silica, giving, respectively, percentages of 64.14, 61.242, and 59.416 of silica.

In two determinations of ferric oxide from separate portions, after solution in sulphuric acid and reduction with zinc, 470 c.c. and 420 c.c. of potassium permanganate, where 1 c.c. = 0.0001 of O, were required, showing respectively percentages of 15.6 and 14 of ferric oxide. These two determinations are probably not quite accurate, the solution of the permanganate being so dilute, but they were intended simply as approximate experiments.

This analysis was conducted in the laboratories of Messrs. Allen and Bayley, of Birmingham, to the latter of whom especially my thanks are due for that unfailing kindness which he has so invariably shown to me, and for the information he has so willingly given me at all times.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from p. 18).

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
- || Following a date signifies publication discontinued.

- GIORNALE FISICO-CHIMICO ITALIANO, ossia raccolta di scritti riguardanti la fisica e la chimica degli italiani di Francesco Zantedeschi. 8vo. Venezia, 1846-'48 [-'51 (?)]
- GIORNALE DI CHIMICA E VETERINARIA. Di Pozzi. 8vo. Milano, 18**(?)
- GIORNALE DI FARMACIA, CHIMICA E MATERIA MEDICA APPLICATA ANCHE ALLA VETERINARIA. Diretto dal Mariano Gajani. 4to. Ancona, 1861, '62.
- GIORNALE DI FARMACIA, CHIMICA E DI SCIENZE AFFINI. Diretto da F. Chiappero; pubblicato della società di farmacia di Torino. 29 vols., 12mo. Torino, 1852-'80+
- GIORNALI DI FARMACIA, CHIMICA E SCIENZE ACCESSORIE; ossia raccolta delle scoperte, ritrovati e miglioramenti fatti in farmacia ed in chimica. Compilato da Antonio Cattaneo. 19 vols., 8vo. Milano, 1824-'34.

Continued under the title :

- [a] Biblioteca di farmacia, chimica, fisica, medicina, chirurgia, terapeutica, storia naturale, [etc.]; compilato da Antonio Cattaneo. 23 vols. (I-XXIII.), 8vo. Milano, 1834-'45.

Continued under the title :

- [b] Annali di chimica applicata alla medicina civile, alla farmacia, alla tossicologia, all'igiene, alla fisiologia, alla patologia ed alla terapeutica, compilati da Giovanni Polli. 80 vols. (I-LXXX.), 8vo. Milano, 1845-'84.

United with Rivista di chimica medica e farmaceutica, and continued under the title :

- [c] Annali di chimica medico-farmaceutica e di farmacologia. Direttori: P. Albertoni, J. Guareschi; Condirettori: A. Pavesi, G. Colombo. Milano, 1885+

- GIORNALE DI FISICA, CHIMICA ED ARTI. Dal Majocchi. 8vo. Milano, 1839.
- GIORNALE DI FISICA, CHIMICA E STORIA NATURALE, ossia raccolta di memorie sulle scienze, arti e manufatti ad esse relative. Di L. Brugnatelli. 10 vols, 4to. Pavia, 1808—'17.

Continued under the title :

- [a] Giornale di fisica, chimica, storia naturale, medicina ed arti dai Brugnatelli, Brunacci e Configliachi, compilato dal Gaspare Brugnatelli. Decade seconda. 10 vols. (I-X.), 4to. Pavia, 1818-'27.||

GÖTTLING, J. F. A.
See Almanach für Schiedekünstler.

GREN, F. A. C.
See Journal der Physik.

GRETSCHEL, H.
See Jahrbuch der Erfindungen.

(To be continued).

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

NOTICES OF BOOKS.

On Certain Indications of the Existence of an Allotropic Modification of Elementary Nitrogen, and on the Synthesis of Ammonia. By GEORGE STILLINGFLEET JOHNSON. London: J. and A. Churchill.

THE subject of this pamphlet is one of the first importance, both theoretically and practically. The author first cites the experiments of Donkin, Berthelot, Dehérain and Maquenne, P. and A. Thénard, and H. Ste.-Claire Deville, showing the production of ammonia and of its salts by the action of the silent discharge, or of electric sparks upon mixtures of atmospheric nitrogen and oxygen, of watery vapour and nitrogen gas, and of hydrogen, nitrogen, and hydrochloric acid.

These results have been laid before the scientific world in the *Proceedings of the Royal Society*, in the *Comptes Rendus*, and in the *Bulletin de la Soc. Chimique*. So far as we are aware they have never been controverted.

Mr. Johnson then refers to his earlier experiments—as detailed in the *Journal of the Chemical Society*—on the synthesis of ammonia from the nitrogen gas evolved from a boiling solution of ammonium nitrite mixed with hydrogen, and then passed over heated spongy platinum. He now reviews the criticisms which have been urged against this experiment, and demonstrates the purity of the nitrogen and that of the hydrogen. He finds that if pure nitrogen from ammonium nitrite is passed through a hot tube before being mixed with the hydrogen, no ammonia is produced on passing the mixture over hot platinum-sponge. But as soon as the tube transmitting the nitrogen is allowed to grow cold the production of ammonia is very distinct. Hence the author infers that “the gas evolved from hot solutions of ammonium nitrite contains an allotropic or active form of nitrogen, which differs from ordinary nitrogen in possessing the property of forming ammonia by direct synthesis with hydrogen in presence of heated spongy platinum, and which is converted into ordinary inactive nitrogen by the action of heat, precisely as ozone is converted into ordinary oxygen by the same agency.” He adduces experiments to prove that the ammonia-forming gas present in the gas evolved from the heated solution of ammonium nitrite is not due either to nitric or nitrous oxide. Mr. Johnson sums up this chapter to the effect that the ammonia produced in this case is not due to any impurity in the hydrogen, but to an ingredient of the nitrogen which is either an unknown compound of nitrogen which is decomposed by transmission through an ignited tube, or more probably an allotropic active modification of nitrogen itself.

In the third chapter we find an account of further experiments on the nature of the gas produced by the action of heat upon solutions of ammonium nitrite. Here we note an important result. The gas evolved from a pure solution of ammonium nitrite at temperatures below 90° is partially active. That given off at higher temperatures is entirely inactive. This confirms the observation that active nitrogen is rendered inactive by a high temperature.

The foregoing experiments, however, though theoretically interesting, are practically unimportant. Very different is the case with the experiments on atmospheric nitrogen. The author, like other chemists, has failed in producing ammonia by passing atmospheric nitrogen, recently heated and then mixed with hydrogen, through red-hot tubes in presence of platinum-sponge. He has, however, in an experiment described in a paper read before the Royal Society, obtained ammonia from atmospheric nitrogen which had *not been heated*, mixed with pure hydrogen in presence of platinum-sponge. The nitrogen was first made to pass into a glass gas-holder, traversing a vessel filled with sawdust saturated with freshly-precipitated ferrous sulphide. This nitrogen then stood for some days over water holding in suspension ferrous ferrocyanide.

It was then passed in succession through caustic potash, alkaline pyrogallate, strong sulphuric acid, and Nessler reagent. The hydrogen used was purified by successive passage through a mixture of chromic and sulphuric acids, and through Nessler reagent. Ammonia was always formed except the nitrogen had been heated, but the quantity was small, never exceeding 1½ m.grm. from 10 litres of nitrogen.

To set aside this result it has been contended that the ferrous ferrocyanide, when suspended in water, gives off a hypothetical nitrogenous gas which combines with hydrogen to form ammonia in presence of platinum-sponge. No evidence was given of the existence of this alleged gas. Mr. Johnson has completely annihilated this objection by showing that the same results were obtained if the nitrogen is allowed to stand over water holding in solution ferrous hydrate.

The most important experiment comes at the conclusion. We quote it in full in the hope—in which we feel convinced that the author participates—that it may be critically repeated by competent observers:—“Into an ordinary eudiometer tube, full of mercury, pure nitrogen gas, obtained by any method, is introduced and measured. Next admit three times its volume of pure hydrogen gas, and introduce into the gaseous mixture a fragment of wood-charcoal which has previously been ignited in hydrogen gas, or, better, in a mixture of three volumes of hydrogen with one volume of nitrogen gas. Now pass the spark continuously through the wires of the eudiometer. About 4 to 6 c.c. of the mixture are combined and absorbed by the charcoal per hour, until finally the whole of the gas may be made to disappear; after which, if the charcoal be removed, it will be found impregnated with ammonia.”

We certainly think that the author has made out a good *prima facie* case for his views. It should be the task of dissidents to point out any sources of error which may have vitiated his conclusions.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. c., No. 23, June 8, 1885.

Action of Chloroxy-carbonic Ether upon Potassium Cyanate.—MM. Wurtz and Henninger.—A posthumous memoir as far as M. Wurtz is concerned. On heating on the water-bath in a vessel fitted with an ascending refrigerator a mixture of 25 parts potassium cyanate in fine powder and 33 parts chloroxy-carbonic ether the authors obtained carboxethyl cyanate, a compound fusible at 118° to 119° and having the composition $C_4H_5NO_3$, carbonic acid mixed with traces of carbon monoxide and ethyl chloride being given off. The reaction is similar if potassium cyanate and chloroxy-carbonic acid are heated along with anhydrous ether, though there is also formed a small quantity of $C_{10}H_{15}N_3O_7$, a body fusible at 107°. If aqueous ether is used there remains a mixture of the body fusible at 107°, and of carboxyl-urethane. If the original mixture of chloroxy-carbonic ether and potassium cyanate is heated to 200° in a closed vessel, the sole product is cyanuric ether.

New Kind of Metallic Spectra.—Lecoq de Boisbaudran.—Already inserted.

Rapid Determination of Nitrogen when simultaneously present in the Organic, the Ammoniacal, and the Nitric Conditions.—A. Houzeau.—In the soda-lime process the author has previously substituted a direct

alkalimetric method which dispenses with standard solutions. After noticing the methods of Guyard and Ruffle, M. Houzeau describes his new method which depends on the complete conversion into ammonia of fixed nitrogenous substances, if ignited at a red heat in contact with a mixture of sodium acetate and hyposulphite and soda-lime, and on the absorption of the ammoniacal gas in a sufficient volume of water. In practice it is merely necessary to have a standard acid, soda-lime, and a saline mixture, composed of sodium acetate and hyposulphite (thiosulphate). To prepare this mixture equal weights of the two salts are melted together in their water of crystallisation. When cold the saline mass is finely pulverised and preserved in stoppered vessels. If the accidental presence of ammonia in these salts is suspected, 1 per cent of solid caustic soda, free from nitre, is introduced into the liquefied mixture. To effect the determination about 2 grms. of the powdered saline mixture are first introduced into the bottom of the combustion-tube, (glass or iron), mixed with its own weight of coarsely powdered soda-lime, and upon that a stratum of a few centimetres of the same soda-lime unmixed. From 0.5 grm. to 10 or even 25 grms., (the latter weights in case of arable soils) are reduced to very fine powder, and intimately incorporated with 10 grms. or 15 c.c. (?) of the saline mixture, after which the whole is as intimately mixed with 10 grms. of soda-lime in fine powder. The whole is introduced into the combustion-tube, then filled up in the ordinary manner with soda-lime and a small stratum of broken glass. The combustion-tube is heated from the front backwards. The saline mixture placed at the back of the tube serves as a substitute for the oxalic acid or calcium oxalate generally used, and gives when ignited about 200 c.c. of inert gases which rinse out the tube. In scientific determinations the ammoniacal gas is collected in the ordinary manner in a Will's bulb tube half-filled with pure water coloured with a few drops of neutral litmus. The neutralisation of the ammonia is effected progressively in the bulb-tube as it is produced by means of an upright Mohr's burette placed above the orifice of the exit tube, which must be straight. The mixture of the standard acid and the ammoniacal water is effected automatically by the escape of the gases. The standard acid is such that 1 c.c. represents 0.01 nitrogen, thus dispensing with calculation. In technical assays the bulb-tube is dispensed with, and in its stead is used a simple escape tube, leading into a decilitre of water. Explosions have never occurred during the use of this method.

Radiations Emitted by Incandescent Carbons.—Felix Lucas.—Up to a certain point the luminosity of the carbons increases with the intensity of the electric current and the consequent temperature. After this point, about 4713° C., the luminous intensity diminishes. It is probable that the thermic radiations, which are at first dark and then luminous, passing from red to white, ultimately go beyond the violet rays, and cease to be visible.

Measurement of Adjusted Currents.—E. Hospitallier.—The author shows that in case of fluctuating currents the intensity must be measured with an electro-dynamometer, and the difference of potentials with a quadrant electrometer, or a Cardew's voltmeter.

Thermo-chemical Study on Accumulators.—M. Tscheltzow.—In Faure's element the fundamental reaction consists in the sulphatation of the two electrodes.

Action of Certain Metals on the Mixture of Acetylene and Air.—F. Bellamy.—The author has observed a property of this gaseous mixture not hitherto recorded. On introducing into a wide tube traversed by a mixture of acetylene and air a spire of platinum or silver wire heated scarcely to incipient redness, there is at once detonation and inflammation of the gases, but it is rare for the spiral to begin by being incandescent, and when this happens the light is fugitive and appears only at a few points. On the contrary, a spiral of copper at incipient

redness begins by becoming incandescent, and assumes a bright lustre, like that of platinum, in the same apparatus. The incandescence persists for some seconds, and generally finishes by causing the detonation of the gaseous mixture. A spiral of iron behaves like copper, but the incandescence is not easily obtained. A platinum spiral in hydrogen becomes brightly incandescent and causes detonation, whilst copper and iron remain dark and inactive.

Cerium and Lanthanum Sulphides.—P. Didier.—The author obtains cerium sulphide by passing a current of very dry hydrogen sulphide over ceroso-ceric oxide placed in a boat of carbon and heated in a porcelain tube. The sulphide thus obtained varies in colour from vermilion to black according to the temperature at which it has been produced. Its composition is CeS , if $Ce=47$. Lanthanum sulphide obtained in a similar manner differs from the cerium sulphide merely by its yellow colour and its more ready decomposition by water. Certain chemists, considering the specific heat of the metals of the cerium group have been led to regard their lower oxides as sesquioxide compounds. We see, on the contrary, that the ease with which their sulphides are formed, the stability of the latter in presence of water, and their behaviour with weak acids approximate them to the metals of the iron-group. The above are not the only chemical reactions which differentiate the lower oxides of the cerium group from the sesquioxides, such as alumina and ferric oxide.

New Reaction of Digitaline.—Ph. Lafon.—If we treat a trace of digitaline with a mixture of one part pure sulphuric acid and one part of alcohol, and if a drop of ferric chloride is then added a fine greenish-blue colour appears and persists for some hours. The best method of obtaining this reaction is to operate upon a very small quantity of digitaline, to moisten it with a very small quantity of the mixture of acid and alcohol, and to heat gently until a yellowish tint appears, adding then a drop of dilute ferric chloride.

On Aseptol (Orthoxyphenyl-sulphurous Acid).—E. Serrant.—Aseptol is a definite compound. It is salicylic acid in which the sulphuryl radicle, SO_2 , is substituted for carbonyl, CO . It is said to possess remarkable antiseptic and antizymotic properties. It is less poisonous and less offensive than phenol, and is freely soluble in water.

Elective Alcoholic Fermentation.—E. Bourquelot.—The expression "elective fermentation" ought to be finally abandoned. Yeast manifests no preferences.

Journal de Pharmacie et de Chimie.
Series 5, Vol. xi, June 1, 1885.

Studies on the Inhalation of Formene, and of its Chlorine Derivatives.—MM. J. Regnaud and Villejean.—Formene, mixed with air or oxygen in suitable proportions, is void of all anæsthetic power. The substitution of 1, 2, 3, 4 atoms of chlorine for hydrogen, in the group C_2H_4 , produces anæsthetic power in the four chlorine derivatives, but this property does not increase progressively with these substitutions.

Organic Matter Dissolved in the Sulphur Waters of Ax and of the Chain of the Pyrenees.—M. Marcailhou d'Aymeric.—The author finds that, with rare exceptions, the organic matter dissolved varies inversely as the quantity of alkaline sulphide. For determining the organic matter he uses a basic sulphate of alumina prepared as follows:—Into a standard solution of alum, at $\frac{1}{2}$, there are poured by small quantities 12 c.c. of a solution of potash, at $\frac{1}{10}$. A fresh quantity of the potash solution is not added until the precipitate produced is totally redissolved, which requires about two hours. To throw down the organic matter it is sufficient to add to 1 litre of the mineral water 5 c.c. of the solution of aluminium subsulphate.

The Manufacture of Ultramarine from a Sanitary Point of View.—Prof. Jules Arnould.—The only objectionable portion of the process is the calcination, when

sulphurous acid is given off in abundance, and should be absorbed.

Solution of Iodine.—M. Jehn.—Liquid paraffin readily dissolves 5 per cent of iodine, forming a violet solution.

New Reaction of Chloral Hydrate.—M. Hirschfeld.—If a solution of calcium sulphide is poured into a solution of chloral hydrate, after the lapse of half a minute there appears a red colouration, which becomes purple. A fainter but still decided reaction can be obtained by adding sulphuretted hydrogen, and then lime-water, to a solution of chloral hydrate. In about a minute the liquid becomes rose-coloured.

Ozonometric Paper for the Recognition (?) of Diseases.—MM. Bornis and Daniel.—From observations conducted on the Senegal, during five years, the authors conclude that there is no relation between the indications of this paper and the intensity of bilious and yellow fevers. The reaction on the paper is slight when the air is dry, and intense when it is moist.

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Bulletin de la Société Chimique de Paris.
Vol. xliii., No. 10, May 20, 1885.

Formation of Alkaloids in Disease.—A. Villiers.—Already noticed.

On Oxygenated Water.—M. Hanriot.—If dilute oxygenated water is heated in a retort a small portion distils over with the water, whilst the larger part is concentrated in the retort. The decomposition is null until the concentration exceeds 12 vols. 100 grms. oxygenated water at 15 volumes on evaporation in the water-bath yielded 20 grms. of water at 58 vols., and 9 grms. water at 72 vols. In a vacuum there is little decomposition until a concentration of 200 vols. has been reached. Oxygenated water freezes very readily, and the crystals are formed by ice containing oxygenated water interposed. By successive congelations oxygenated water may be strongly concentrated, but after about 70 vols. it no longer congeals in a mixture of ice and salt. If exposed to the intense cold produced by methyl chloride the liquid congeals to a kind of jelly formed of small crystals impregnated with liquid, and on letting them drain we obtain a more concentrated oxygenated water, up to 137 vols. Oxygenated water is acid to litmus; it conducts electricity better than does water. At the positive pole nothing but oxygen is obtained. At the negative pole is given off a mixture of oxygen and hydrogen in variable proportions. The author has studied the action of oxygenated water upon a great number of organic bodies, especially upon non-saturated compounds, and he never finds it behaving like dihydroxyl. Its oxidising action appears most distinct in the aromatic series. It oxidises benzol to phenol, then to pyrocatechin, and to a body which the author believes to be pyrogallol. There are two methods of determining hydrogen peroxide: either directly, by determining the volume of oxygen given off on its decomposition, or indirectly by means of standard solutions.

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Bulletin de l'Association des Elèves de M. Fremy.
2nd Series, No. 1, January, 1885.

Certain Basic Compounds, Oxychlorides and Oxybromides.—G. André.—It is known how easily basic salts are produced, *e.g.*, on pouring ammonia into a solution of lead chloride, or on dissolving litharge in neutral lead acetate, when there may be obtained compounds containing 1, 2, 3 equivalents of lead oxide in excess to 1 equivalent of this oxide in the neutral acetate. The author describes here certain oxychlorides and oxybromides of calcium, barium, strontium, magnesium, zinc, lead, and mercury. He has obtained an undescribed magnesium chloride containing an equivalent of chloride

to one of oxide, and consequently analogous in its composition to those of barium and strontium.

Selenio-urea and its Derivatives.—A. Verneuil.—The author obtains selenio-urea by passing a current of hydrogen selenide into an ethereal solution of cyanamide containing 20 grms. cyanamide per litre. The reaction is facilitated by previously passing into the solution a few bubbles of ammoniacal gas. The brown deposit obtained, separated from the ether by filtration, is strongly pressed, and then dissolved in twice its weight of boiling water, when selenio-urea is obtained in colourless crystals if the light is carefully excluded during the operation. Hydracids, reacting upon selenio-urea at common temperatures and in presence of air, give rise to compounds at once oxidised and condensed, which, so far, have no representatives among the derivatives of urea and of sulph-urea. The substance formed contains the elements of three equivalents of selenio-urea, upon which have been fixed two equivalents of oxygen, and which may be called oxy-tri-selenio-urea.

Improved Burette.—F. Billet.—This apparatus cannot be intelligibly described without the accompanying figure.

No. 2, April, 1885.

On Phosphorus Trifluoride.—H. Moissan.—Phosphorus trifluoride is not, as it has been asserted, a liquid boiling at 60°, but a gaseous body which is not liquefied at 24° by a pressure of 180 atmospheres, but if suddenly released it becomes a liquid which rapidly resumes the gaseous state. At a temperature of -10° and a pressure of 40 atmospheres phosphorus fluoride remains a very mobile liquid, colourless, and having no action upon glass. Gaseous phosphorus trifluoride has density 3.022, its theoretical density being calculated at 3.0775. It is incombustible in presence of air, but if mixed with half its volume of oxygen it detonates in contact with a flame or an electric spark. Its decomposition in presence of water at common temperatures is slow, the products being phosphorous and hydrofluoric acids. The products of the detonation with oxygen are phosphoric acid and a new gas, probably phosphorus oxyfluoride.

On Arsenic Trifluoride.—H. Moissan.—The author obtains this compound by heating a mixture of equal parts calcium fluoride and dry arsenious acid, perfectly free from chlorine, with twice its weight of monohydrated sulphuric acid. It is a colourless, very mobile liquid, having the composition AsF_3 , boiling at 63°. It dissolves iodine, combines with bromine, and dissolves in benzol. In contact with glass at a dark red-heat it yields arsenious acid and silicon fluoride. It is a dangerous compound, as if it touches the skin it produces deep and painful ulceration.

New Apparatus for the Preparation of Solid Carbonic Acid.—L. Cailletet.—An illustrated paper, taken from the *Journal de Physique Theorique et Appliquée*.

A New Preparation of Chlorochromic Acid.—H. Moissan.—If chromic anhydride, perfectly free from sulphuric acid, is brought in contact with gaseous hydrochloric acid red fumes appear, which condense into chlorochromic acid. The reaction is accelerated by the application of heat. The water liberated reacts upon a part of the chlorochromic acid, and at the end of the experiment we find in place of the chromic acid a matter of an oily appearance, soluble in water, and not yet analysed. Gaseous hydrobromic and hydriodic acids do not form analogous chromo-compounds. Absolutely dry chlorine does not attack chromic acid.

Analysis of a Chrysotile.—A. Terreil.—The chief fact brought to light is that the silica resulting from the decomposition of chrysotile by boiling acids retains the original fibrous form of the mineral.

Assay of Fatty Bodies.—Translated from the *Scientific American* (Supplement), January 3rd.

Separation of Alumina from Ferric Oxide.—P. Vignon.—Already noticed under *Comptes Rendus* of March 2nd.

Rapid Analysis of Butters Sophisticated with Margarine.—M. Piallat.—The hydro-cupro-ammonium reagent is prepared by putting into a glass 100 grms. of pure copper sulphate, coarsely pounded, adding 320 grms. of distilled water, and then immediately a small quantity of ammonia, stirring with a glass rod, and then adding ammonia, drop by drop, constantly stirring. There is formed a greenish blue precipitate, whilst copper sulphate remains in solution. At the end of the experiment, when there is no longer any precipitate formed, the ammonia should only be faintly manifest to the smell. Filter, wash the moist precipitate with distilled water until the washings run through colourless. The precipitate is then dried at a temperature not exceeding 25°, and finely powdered. For the qualitative analysis are taken 2 grms. of butter (which must be made in the laboratory to ensure that it is genuine) spread out on a glass plate, and 2 centigrms. of the reagent are incorporated with it by means of a flexible steel spatula. The mixture takes a light turquoise-blue colour. The butter is then scraped up with the spatula and deposited on another glass plate, spreading it out so as to judge its colour. This is then the standard with which the sample in question is compared. This latter is treated in the same manner, and if it contains margarine it will take a greener and more intense colour. One-tenth of margarine is thus perceptible to the eye, and the more the butter contains the more the colour will differ from that of the standard. To render this method quantitative 11 standards are prepared: No. 1 pure, No. 2 mixed with $\frac{1}{2}$ margarine, No. 3 with $\frac{1}{3}$, No. 4 with $\frac{1}{4}$, and so on down to $\frac{1}{10}$. These are all treated with the reagent as above, and the sample in question being likewise so treated

its proportion of margarine may be found by comparing the colours. Such standards must be prepared fresh daily.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3rd Série. Tome xii., April, 1885.

Report presented by M. Bérard on behalf of the Committee of Chemical Arts on M. Houdart's Apparatus for Heating Wines.—The arrangement of the apparatus in question cannot be understood without reference to the accompanying figures. The wines are heated to a uniform temperature of 55° to 60°, which, it is said, kills ferment germs, and renders these "mixtures" proof against further changes.

Determination of Manganese in Iron Works.—A comparison of the volumetric procedures of Volhard, Pattinson, and Hampe.

Cosmos les Mondes.
No. 17, May 25, 1885.

Purification of Water.—The water, previously filtered, is introduced into a cylinder and saturated with oxygen at a pressure of 20 atmospheres. All the organic matters are said to be destroyed, and the water issues in a state of perfect purity.

No. 18, June 1st, 1885.

Development of Electricity in Filtering Mercury.—J. Dechant.—The author, on filtering mercury through a Pfäundler's apparatus, perceived a well-marked development of electricity. On pouring the mercury into another vessel his fingers happened to touch the stream, when he received so smart a shock that part of the mercury was spilt.

ERRATUM.—P. 23, col. 1, line 17 from bottom, for "carbonic acid" read "carbonic oxide."

COMMERCIAL ORGANIC ANALYSIS.

By ALFRED H. ALLEN, F.I.C., F.C.S.,

Public Analyst for the Borough of Sheffield, &c.

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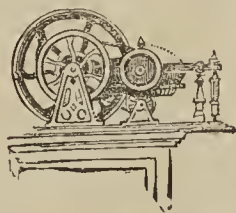
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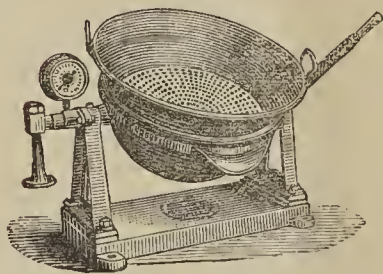
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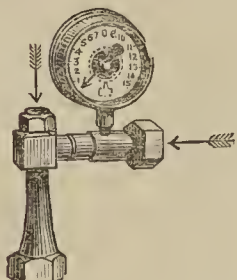
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THE CHEMICAL NEWS.

VOL. LII. No. 1339.

ON THE IDENTITY OF REGIANINE AND JUGLONE.

By Dr. T. L. PHIPSON, F.C.S., &c.

REGIANINE was extracted in 1868 from the fresh green husks of the walnut, and described in the CHEMICAL NEWS the year following.*

It forms golden-yellow crystals (elongated octahedra) which are soluble in alkalis, giving a solution of a very fine purple colour. This curious substance, which, not only by its colour, its crystalline form, and the purple colour of its solution in alkalis, but by its solubility in benzol and its general reactions, is so easily recognised, is doubtless identical with that which Professor Mylius has recently studied, in Germany, under the name of "Juglone."

The alkaline solutions of regianine, after oxidation, are decomposed by hydrochloric acid, yielding the substance termed *regianic acid*, equally obtained with the body called juglone, judging by the properties ascribed to the oxidation product as obtained by Mylius.

If further study should establish the opinion that regianine really possesses the characteristics of a quinone or a phenol, it would be easy to modify its name to the extent of calling it "regianone" or "regianol," rather than "juglone."

Whatever may be the value of the researches of Professor Mylius, which appear to us extremely interesting, we must protest against the habit of describing as new (under the cloak of theoretical considerations) substances discovered long ago by other chemists.

Putney, London, S.W.,
July, 1885.

AN APPARATUS FOR CONTINUOUS EXTRACTION OF SOLID SUBSTANCES BY VOLATILE SOLVENTS.

By GEORGE STILLINGFLEET JOHNSON.

THE apparatus devised by Tollens for the estimation of fixed oils in plants, and figured on p. 100 of Mr. Greenish's translation of Prof. Dragendorff's "Plant Analysis," suggested to me the following arrangement, which has been found very convenient for laboratory use.

Fig. c is a rough sketch showing the essential portions of Tollens's apparatus. The substance to be extracted is confined in the tube *a*, which rests below upon a piece of curved glass rod, *r*. *b* is a condensing tube, which is of course surrounded by cold water, the condensed vapour of the solvent dropping back upon the substance in the tube *a*, and then into the flask *c*.

The chief difficulty which I encountered in working with Tollens's apparatus was that the vapour of the boiling solvent in the flask *c* was constantly blocking back the condensed solvent from above, thus hindering its return into the flask, and also into the tube containing the substance to be extracted, from the condenser.

Fig. A shows the apparatus by which this difficulty was overcome, whilst Fig. B shows the essential parts of the apparatus freed from corks, &c.

In Fig. A, *a* is the flask for the solvent, *b* is the appa-

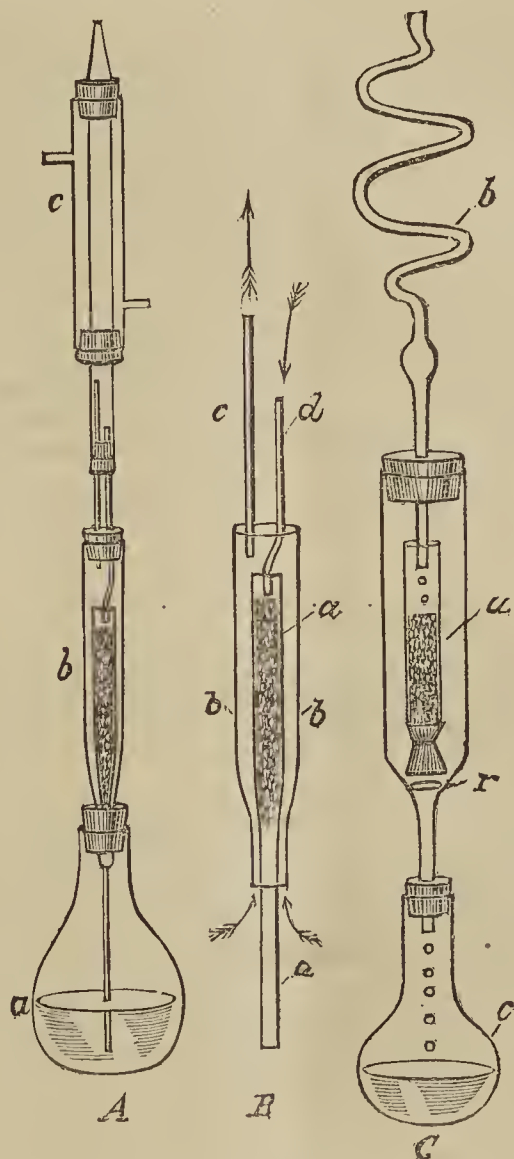
ratus in which the extraction takes place, whilst *c* is an inverted Liebig's condenser.

The peculiarities of the extraction apparatus are best understood by reference to Fig. B.

In Fig. B, the tube *a* is for the reception of the solid to be extracted. The internal diameter of *a* may be about half an inch. It is drawn out below till the internal diameter of the constricted portion is about one-eighth of an inch, and the constricted portion is prolonged till it reaches nearly to the bottom of the flask for the solvent.

A plug of asbestos or glass-wool in the constricted portion of *a* prevents mechanical transference of suspended solid matter into the flask for the solvent.

The tube *a* which has thus been described fits loosely into the tube *b*, whose internal diameter may be about



three-quarters of an inch, and its constricted portion one-quarter of an inch in internal diameter. The constricted portion of the tube *b* just enters the top of the flask for the solvent, into which it fits air-tight by a perforated cork. The upper orifice of *b* also bears a cork perforated with two holes, one of which admits the tube *c*, through which the vapour of the volatile solvent finds access to the condenser, whilst the other gives entrance to the tube *d*, which conveys the condensed solvent back from the condenser into the tube *a*, containing the substance to be extracted. The tubes *c* and *d* enter the central tube of the condenser by a perforated cork.

The vapour of the boiling solvent finds an easy passage between the tubes *a* and *b*, and the condensed solvent gets back into the flask down the tube *a* without being intercepted by vapour from below. Also, the tube *d* (Fig. B), opening just inside the cork in the condenser tube, pre-

* Phipson: "On some Substances Extracted from the Walnut," CHEMICAL NEWS, vol. xx., p. 116.

vents accumulation of liquid in the latter, so that the apparatus, when once started, continues to work automatically.

King's College, London,
July 15, 1885,

THE REMOVAL OF MICRO-ORGANISMS FROM WATER.*

By PERCY F. FRANKLAND, Ph.D., B.Sc., F.C.S.,
Assoc. R. Sch. Mines, Demonstrator of Chemistry in the Normal
School of Science, South Kensington Museum.

(Concluded from p. 29.)

Effect of Subsidence on Micro-organisms in Water.

As in the agitation experiments the water for examination was always taken from the clear upper layers, it became of interest to know whether the micro-organisms would not, by subsidence alone, separate out from the upper layers without the influence of solid particles. In order to ascertain this, three sterilised Winchester bottles were filled up to the shoulder with urine-water, and plugged with sterilised cotton-wool. The bottles were placed in a room (temp. about 10° C.) and left at perfect rest; the number of organisms in the urine-water was ascertained at the outset of the experiment; again at the end of six hours the number was determined in one of the bottles, at the end of twenty-four hours in the second bottle, and lastly, at the end of forty-eight hours in the third bottle. The numbers found were as follows:—

Hours of subsidence.	No. of centres found per c.c. of water.
0	1,073
6	6,028
24	7,262
48	48,100

These experiments show that, far from there being any tendency for the upper layers of water to become deprived of organisms by subsidence, the tendency is for the number to increase very rapidly indeed.

Effect of Clark's Process on Micro-organisms in Water.

Owing to the encouraging results obtained by agitating water with finely divided chalk, it appeared probable that still more striking effects would be obtained if the chalk were present in a more finely divided state, such as is the case when water is softened by means of lime (Clark's process). In order to ascertain the effect of Clark's process in this respect, three stoppered Winchester bottles were taken, and to each were added 2 litres of ordinary Thames water, to which some urine-water had been added, so as to impart a convenient number of organisms. To two of these bottles 100 c.c. of clear lime-water (1 c.c. = 0.0013 gm. CaO) were added, calculated to remove 11.6 parts of carbonate of lime per 100,000 parts of the water. Each of these bottles was violently shaken, and then allowed to subside for eighteen hours. The third bottle to which no lime-water was added, was first tested for the number of organisms contained in the water used in the experiment. After eighteen hours the two bottles to which lime-water had been added were tested without disturbing the precipitate, and also the third bottle containing the untreated water which had been left at rest in the same place as the other two. The following results were obtained:—

Untreated water	85 centres per c.c.
" " after 18 hours' rest ..	1922 " "
Water after Clark's process and 18 hours' subsidence	42 " "

In order to appreciate the real effect of the treatment by Clark's process, it is necessary that the treated waters should be compared, not with the original water, but with the latter after eighteen hours' rest; for this shows what the condition of the water would have been at the time of testing if no lime-water had been added. It is evident that after the subsidence of the carbonate of lime precipitate has taken place, there is every probability of the organisms becoming again distributed throughout the upper layers of the water, and with a view of determining whether this actually takes place or not, the same waters which had remained well stoppered and at rest were again tested after the lapse of ten days. It was then found that the untreated as well as the softened waters contained immense numbers of organisms in their upper layers.

As the effect of Clark's process in removing organisms from water appeared to be of great practical importance, the above experiments were repeated, the conditions being essentially the same as before. The following results were obtained:—

Untreated water	37 centres per c.c.
" " after 21 hours' rest ..	42 " "
" " after 48 hours' rest ..	298 " "
Water after Clark's process and 21 hours' subsidence	22 " "
Water after Clark's process and 48 hours' subsidence	166 " "

Owing to the number of organisms in the original water having been very much smaller, the results are not so pronounced as in the former case; the main facts are, however, fully substantiated.

It appeared also to be of interest to ascertain what results are obtainable on the large scale. For this purpose the process of softening as practised at the Colne Valley Waterworks at Bushey near Watford, was investigated, as well as the new modification of Clark's process devised by Messrs. Gaillet and Huet, which is now in operation at Mr. Duncan's Clyde Wharf, Victoria Dock. I am indebted to Mr. Verini, of the Colne Valley Waterworks, as well as to Mr. Duncan and Mr. Newlands, for their kindness in permitting me to carry out these experiments.

At the Colne Valley Waterworks, the hard water obtained from a deep well in the chalk is mixed with the requisite proportion of clear lime-water, and then allowed to settle in open tanks. The subsidence is so rapid that under favourable circumstances the upper layers of water are, after three hours' time, fit for distribution. On the occasion of my visit, however, boring operations were being carried on, and the water was in consequence milky, and the necessary subsidence after softening had to be increased to two days. I was unfortunately unable to obtain a perfectly representative sample of the water before softening, and the number of organisms found in the untreated water is probably in excess of that which was actually present in the unsoftened water itself. The following results were obtained:—

Unsoftened water	322 centres per c.c.
Water after softening and 2 days' subsidence (from main) ..	4 " "

The almost complete absence of organisms in the softened water shows how perfect a result is obtained even on the large scale.

In the process of softening, due to Messrs. Gaillet and Huet as practised at Mr. Duncan's, the water from an artesian well is mixed with a suitable proportion of lime-water and caustic soda, the mixture being then made to pass upwards through a tower provided with diaphragms, which accelerate the precipitation of the carbonate of lime. The passage through this tower occupies a period of about 2 hours. Samples of water before and after treatment were examined with the following results:—

* A Paper read before the Royal Society, June 18 1885.

Well water 182 centres per c.c.
(38 caused liquefaction of gelatin).
,, after softening .. 4 centres per c.c.
(None of the centres caused liquefac-
tion of gelatin.)

These experiments, as well as those made in the labor-
atory, show that the softening of water by Clark's process
is attended with a great reduction in the number of
organisms, the best results being obtained when the clear
liquid is separated from the precipitated carbonate of lime
as speedily as possible.

Pasteur's Filter.—Through the kindness of Colonel Sir
Francis Bolton, R.E., I have had the opportunity of ex-
amining one of the above filters, in which the water is
made to pass through a cylinder of biscuit porcelain. The
one with which my experiments were made consisted of
ten such cylinders, and the water (ordinary Thames water)
was forced through under a pressure of between 30 and 40
feet of water. Under these circumstances the filter com-
menced by yielding 1 litre in 40 minutes, or 36 litres per
24 hours, but already at the end of a fortnight's continuous
action it was only delivering 1 litre in 1 hour 14 minutes,
or rather less than 20 litres per 24 hours; and after 2½
months the rate of filtration was 1 litre in 1 hour 22
minutes, or 17½ litres in 24 hours.

The water both before and after filtration was examined
for micro-organisms with the following results:—

Thames water 54 centres per c.c.
,, after filtration .. 0

The water before and after filtration was also submitted
to chemical analysis with the following result:—

Results of Analysis expressed in Parts per 100,000.

	Thames water.	
	Before filtration.	After filtration.
Total solid matters	33·70	30·04
Organic carbon	0·282	0·284
,, nitrogen	0·028	0·027
Ammonia	0	0
Nitrogen as nitrates and nitrites	0·288	0·289
Total combined nitrogen	0·316	0·316
Chlorine	1·9	1·9
Temporary hardness	15·7	14·4
Permanent ,,	4·9	5·3
Total ,,	20·6	19·7

Both samples were clear and palatable.

It thus appears that although this filter, when new,
effects the complete removal of the micro-organisms
in the water it has but a very trifling influence upon the
chemical composition of the water, the only change in
this respect being a slight diminution in the amount of
mineral matter present.

Micro-organisms in Potable Water.

I have also submitted numerous samples of natural
waters of different of origin to examination for the number
of micro-organisms which they contain. My investigation
in this direction is, however, still far from complete, but I
append the results which I have obtained from a monthly
examination of the various waters supplied to the Metro-
polis during the present year. When the history of the
water is accurately known, and due precautions in
collecting samples have been taken, there can be no doubt
that in many cases it is capable of throwing considerable
light upon the quality of water and in assisting to interpret
the results of chemical analysis.

The method of collecting samples which has been em-
ployed by me is the following:—

Small (about 3 oz.) bottles, accurately stoppered, and
sterilised by being heated to 150° C. for at least three hours,
are kept tightly stoppered until they are to be used. In
taking the sample, the outside of the bottle is well washed
in a stream of the water to be examined; the stopper is
then removed, the bottle nearly filled with water, and the
stopper replaced as rapidly as possible. The examination
of the water should follow as soon as possible after
collection.

The following results were obtained with samples taken
as above from the mains of the various companies supplying
London:—

	No. of centres per c.c. of water.		
	January.	February.	March.
Chelsea	8 (0 liq.)*	23 (2 liq.)	10 (0 liq.)
West Middlesex ..	2 (0 liq.)	16 (2 liq.)	7 (0 liq.)
Southwark	13 (0 liq.)	26 (2 liq.)	246 (1 liq.)
Grand Junction ..	382 (4 liq.)	57 (23 liq.)	28 (12 liq.)
Lambeth	10 (2 liq.)	5 (0 liq.)	69 (1 liq.)
New River	7 (4 liq.)	7 (0 liq.)	95 (1 liq.)
East London. ..	25 (0 liq.)	39 (0 liq.)	17 (0 liq.)
Kent	10 (0 liq.)	41 (0 liq.)	9 (1 liq.)

* Liq. denotes that the organisms caused liquefaction of the gelatin.

It would be premature to draw any conclusions from
these results, and I purpose to continue these observa-
tions over a longer period of time.

The waters were also at the same time submitted to
chemical analysis, so that their biological and chemical
characters might be compared; the results are given
below.

General Conclusions.—(1.) Of the substances experi-
mented with, only greensand, coke, animal charcoal, and
spongy iron were found to wholly remove the micro-
organisms from water filtering through them, and this
power was in every case lost after the filters had been in
operation for one month. With the exception of the
animal charcoal, however, all these substances, even after
being in action for one month, continued to remove a very
considerable proportion of the organisms present in the

Results of Analysis expressed in Parts per 100,000.

LONDON WATERS.	Temperature in Centigrade degrees.			Total solid matter.			Organic carbon.			Organic nitrogen.			Ammonia. J., F., M.	Nitrogen as nitrates and nitrites.		
	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.		Jan.	Feb.	Mar.
<i>Thames.</i>																
Chelsea	3·8°	5·9°	6·2°	30·78	31·04	30·24	0·166	0·188	0·192	0·017	0·017	0·033	0	0·251	0·272	0·242
West Middlesex ..	4·0	6·8	7·5	30·50	30·40	30·60	0·171	0·210	0·218	0·028	0·021	0·031	0	0·267	0·275	0·253
Southwark	4·4	6·8	7·5	31·16	29·74	30·04	0·221	0·286	0·181	0·053	0·025	0·030	0	0·291	0·283	0·241
Grand Junction ..	2·8	6·0	6·8	27·90	30·14	30·46	0·255	0·314	0·150	0·043	0·033	0·023	0	0·181	0·278	0·251
Lambeth.. ..	3·7	6·4	6·9	25·50	27·26	30·50	0·181	0·179	0·174	0·046	0·019	0·021	0	0·181	0·219	0·256
<i>Lea.</i>																
New River	3·4	5·9	6·8	31·80	31·32	28·14	0·085	0·080	0·100	0·015	0·012	0·019	0	0·326	0·361	0·272
East London	3·8	6·0	7·2	35·54	36·70	34·90	0·192	0·200	0·200	0·043	0·019	0·034	0	0·341	0·402	0·327
<i>Deep Wells.</i>																
Kent.. ..	12·0	12·0	12·6	41·36	35·40	37·12	0·039	0·024	0·033	0·010	0·006	0·006	0	0·463	0·416	0·423

unfiltered water, and in this respect spongy iron and coke occupy the first place.

(2.) The results obtained by agitating water with various solid materials show that a very great reduction in the number of suspended organisms may be accomplished by this mode of treatment, and the complete removal of all organisms by agitation with coke is especially worthy of notice.

(3.) Again, the results obtained with Clark's process show that we possess in this simple and useful mode of treating water a means of greatly reducing the number of suspended organisms.

(4.) Thus, although the production in large quantity of sterilised potable water is a matter of great difficulty, involving the continual renewal of filtering materials, there are numerous methods of treatment which secure a large reduction in the number of organisms present.

Moreover, in judging of the value of filtering materials from examinations of this kind, it is only reasonable that a preference should be given to those materials with which a practically pure cultivation is obtained in the filtrate over those materials which appear to exercise no selective action upon micro-organisms.

In conclusion, I would point out that it is very desirable that experiments of this kind should be greatly multiplied and repeated under varying conditions, and it is my intention to continue and extend this examination.

NEW PROCESS FOR THE DETECTION AND THE RAPID DETERMINATION OF SMALL QUANTITIES OF NITRIC ACID IN AIR, WATER, AND SOILS.

By A. GRANDVAL and H. LAJOUX.

THIS process depends on the transformation of phenol into picric acid, and on the intensity of the colouration of ammonium picrate.

To determine a nitrate in solution it is converted into ammonium picrate by the method indicated below, and the tint obtained is compared with that of a standard solution by means of a Duboscq colorimeter.

The process requires the use of a sulpho-phenic solution and of a standard solution of potassium nitrate. The sulpho-phenic reagent is prepared by mixing:—

Pure phenol	3 parts
Monohydrated sulphuric acid. .. .	37 "
	40 parts

The standard solution of potassium nitrate contains per litre 0.936 grm. of this salt, a quantity corresponding to 0.50 grm. of nitric anhydride.

If we have to determine a pure nitrate dissolved in water, we pour into a porcelain capsule a volume V of this liquid, and evaporate it to dryness on the water-bath. Let cool, and add to the residue an excess of the sulpho-phenic reagent, applying it by means of a stirrer over every part of the inside of the capsule, so that no part of the residue may escape the reaction. We add then a few c.c. of distilled water and then an excess of ammonia. We obtain thus a solution of ammonium picrate, which is diluted with distilled water so as to make up the original volume, V.

We operate in the same manner upon an equal volume of the standard solution of potassium nitrate, bringing the solution of picrate obtained to this volume. We then compare the two coloured liquids by means of Duboscq's colorimeter.

Let H and H' be the heights of the columns of liquid corresponding, the former to the liquid under analysis, and the latter to the standard nitrate. Let x be the

weight of nitric acid sought and p that contained in the volume V of the standard solution; we have then,—

$$(a.) \quad \frac{x}{p} = \frac{H'}{H},$$

whence,

$$x = p \frac{H'}{H}.$$

It must be remarked that the difference in the proportion of nitric acid in the two liquids compared must not differ too widely, otherwise, the two tints being too different, it might happen that one of the two scales of the instrument would not be extensive enough. Therefore, to dispense with trials, we prepare with solutions of potassium nitrate of different strengths coloured solutions forming a scale of tints, among which we select that which approaches most closely to the tint obtained with the substance under analysis.

It is evident that it is not necessary for the volumes of the liquids to be equal. It may happen that the liquid obtained in the analysis has a colour so faint that we cannot make up the volume V with the standard liquid. We then make of it a volume v , and in that case the quantity of nitric acid is given by the formula—

$$(b.) \quad x = p \frac{H' V}{H v}.$$

The numerous experiments which we have made prove that we may determine the nitric acid contained in a liquid with so close an approximation that we may feel certain at least of the fifth decimal. The process is applicable to very minute quantities, since we can determine the nitric acid contained in 1.40 c.c. of the normal liquid. This quantity being 0.0000125 grm., we have found 0.0000120 grm.—*Comptes Rendus*.

A NEW METHOD OF DETERMINING CADMIUM.

By A. CARNOT and P. M. PROROMANT.

IF to a neutral solution of a cadmium salt there is added a certain quantity of a disodic phosphate, there is formed a flocculent precipitate of cadmium phosphate. This salt is easily transformed by the addition of a few drops of ammonia into a crystalline product having the appearance of anthracen or naphthalin, and which, in a boiling liquid, is quickly deposited in thin plates of a pearly white. If dried in a vacuum or at about 40°, this salt corresponds in composition to a cadmium-ammonium phosphate. If heated to full redness it is decomposed, losing its ammonia, and being converted into a cadmium pyrophosphate. The authors find it, however, preferable to use for the production of the ammoniacal double salt the salt of phosphorus recommended by M. F. Mohr for the determination of magnesia. Experiment showed the advantage of working in presence of a considerable quantity of ammonium chloride. This salt facilitates the reaction, and renders the precipitation complete. The salt of phosphorus must be employed in excess, and variable quantities seem to have no effect upon the result of the determination.

In the author's experiments 26 c.c. of a solution containing 19.840 grms. cadmium per litre were mixed with 25 c.c. of a solution of ammonium chloride saturated in the cold. The whole having been brought to a boil, we add 50 c.c. of a solution of salt of phosphorus saturated like the former, and previously heated to about 60°. In these conditions the flocky precipitate formed at first is converted in less than two minutes into an ammoniacal phosphate. It is let boil for a few minutes, and when the salt is well formed the liquid is let cool. The deposit is filtered, washed with cold water, and dried at 100°. The precipitate detaches itself from the filter so completely that the latter need not be incinerated. The product ignited at a full (but not bright) red-heat leaves the white pyrophosphate, which is scarcely hygroscopic and not

volatile at a red-heat; 100 parts contain Cd = 56.2819. This salt melts at a bright red-heat and adheres to the crucible. This method is much more expeditious and safe than the determination as cadmium sulphide.

In the absence of ammonium chloride the results are less satisfactory. The presence of sodium and ammonium acetates, and especially of free acetic acid, should be avoided.

The authors are now endeavouring to obtain the ammoniacal metaphosphate and pyrophosphate, and intend to examine the action of alkaline arseniates in presence of ammonia, and to study the advantage which may be derived from the method just described for the separation of cadmium from certain other metals.—*Comptes Rendus*.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from p. 33).

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
|| Following a date signifies publication discontinued.

HELLER, J. F.
See Beiträge zur physiologischen und pathologischen Chemie.

HERBSTÄDT, SIG. F.
See Archiv der Agriculturchemie; also Bibliothek der neuesten physisch-chemischen - - - Literatur.

HIRZEL, H.
See Jahrbuch der Erfindungen.

HOFMANN (A. W.), AND DE LA RUE.
See Annual Report of the Progress of Chemistry.

HOFFMANN'S JAHRESBERICHT.
See Jahresbericht über die Fortschritte der Agriculturchemie.

HOPPE-SEYLER.
See Zeitschrift für physiologische Chemie.

HORKEL, JOH.
See Archiv für die thierische Chemie.

95. INTRODUCTION AUX OBSERVATIONS SUR LA PHYSIQUE, SUR L'HISTOIRE NATURELLE ET SUR LES ARTS. Par l'abbé Rozier. 18 vols., 12mo. Paris, 1771, '72.

A second edition in 2 vols., 4to, was published in 1777. Vol. II. has also the title:

Tableau du travail annuel de toutes les académies de l'Europe; ou observations sur la physique, sur l'histoire naturelle et sur les arts et métiers. Par Jean Rozier. 1 vol., 4to. Paris, 1777.

Continued under the title:

- [a] Observations et mémoires sur la physique, sur l'histoire naturelle et sur les arts et métiers. Par l'abbé Rozier. 1 vol., 4to. Paris, 1773.

Continued under the title:

- [b] Observations sur la physique, sur l'histoire naturelle et sur les arts. Par l'abbé Rozier [from 1779] et J. A. Mongez [from 1785] et de la Méthérie. 42 vols. (II.-XLIII.), 4to. Paris, 1773-'94.

Continued under the title:

- [c] Journal de physique, de chimie, d'histoire naturelle et des arts. Par Jean Claude Laméthérie [from 1817] et H. M. Ducrotay de Blainville. [From vol. LXXXV., by de Blainville alone.] 53 vols. (XLIV.-XCVI.), 4to. Paris, 1794-1822.||

Suppléments. 2 vols., 4to. Paris, 1778, 1782.

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

Vol. x. contains: Table des articles contenus dans les volumes in 4to de ce recueil imprimés depuis le commencement de 1773 et dans les 18 vols. in 12mo imprimés depuis Juillet 1771, jusqu'à la fin de 1772, actuellement imprimés en 2 vols. in 4to sous le titre d'Introduction aux observations sur la physiques, &c.

Vol. XXIX., 1786, contains: Tale générale des articles contenus dans les vingt volumes de ce journal depuis 1778.

Vol. LV., 1802, contains: Table générale des articles contenus dans les vingt-six derniers volumes du Journal de physique, depuis 1787 jusqu'en 1802, pour faire suite à celle qui est imprimée à la fin du second volume de l'année 1786. Par L. Cotte.

JACOBSEN, EMIL.
See Chemische Industrie; also Chemisch-technisches Repertorium.

JAHRBUCH DER CHEMIE UND PHYSIK; Schweigger.
See Allgemeines Journal der Chemie.

96. JAHRBUCH DER ERFINDUNGEN UND FORTSCHRITTE AUF DEN GEBIETEN DER PHYSIK UND CHEMIE, der Technologie und Mechanik, der Astronomie und Meteorologie. Herausgegeben von H. Hirzel und H. Gretschel [later, by H. Gretschel and G. Wunder.] 20 vols., 8vo. Leipzig, 1865-'84+

Register. Vols. I.-V. 1869.

(To be continued).

ACTION OF AMMONIUM HYDRATE ON THE HALOGEN SALTS OF LEAD.

By JULIAN WOOD and J. L. BORDEN.

In "Watts's Dictionary" (iii., 556) we find the statement that by decomposing lead chloride with ammonia a hydrated oxychloride, $Pb_4Cl_2O_3 \cdot H_2O$, is obtained. As certain observed facts seemed to disagree with this, a set of experiments were undertaken to determine what oxychloride or oxychlorides were formed by this action of ammonium hydrate and the conditions of formation.

The lead chloride for these experiments was gotten by precipitating pure lead nitrate with hydrochloric acid. The precipitate was thoroughly washed and dried. To about 7 grains of this chloride 140 c.c. of ammonia solution was added, the mixture being heated then some six hours upon a sand-bath. The residue was washed, dried, and analysed with the following results:—

- I. 0.6200 grm. of substance gave 0.3585 grm. AgCl.
P.c. Cl = 14.20.
The water was determined, and Cl calculated on a dry basis = 14.68.
- II. 0.5003 grm. of substance gave 0.2950 grm. AgCl.
P.c. Cl = 14.57.
No water in the specimen.
- III. 0.5650 grm. of substance gave 0.3265 grm. AgCl.
P.c. Cl = 14.29.
Calculated water-free = 14.54.
- IV. 1.3345 grms. of substance gave 1.5340 grms. $PbSO_4$. P.c. Pb = 78.52.
Water-free = 81.14.
- V. H_2O in air-dried substance = 3.33 p.c.

Calculated, per cent.		Found, per cent.				
		I.	II.	III.	IV.	V.
Pb ₂	.. ..	82.56				
O	.. ..	3.31				
Cl ₂	.. ..	14.13	14.68	14.57	14.54	
H ₂ O	.. ..	3.46				3.33

Again, between 10 and 11 grms. of the chloride were heated with 175 c.c. ammonia solution for twelve hours on a water-bath, then washed and dried as before.

- I. 0.145 gm. of substance gave 0.0525 gm. AgCl.
P.c. Cl = 8.61.
Water-free = 8.70.
- II. 0.4935 gm. of substance gave 0.1490 gm. AgCl.
P.c. Cl = 7.48.
Water-free = 7.56.
- III. 0.5035 gm. of substance gave 0.1594 gm. AgCl.
P.c. Cl = 7.81.
Water-free = 7.89.
- IV. 1.5353 grms. of substance gave 1.9420 grms. PbSO₄.
P.c. Pb = 86.31.
Water-free = 87.26.

Calculated, p.c.	I.	Found, p.c.	III.	IV.
Pb ₄ ..	87.53	8.73	7.56	7.89
Cl ₂ ..	7.48			
O ₃ ..	4.99			

These two experiments, then, would point to the formation of two entirely different bodies, the first having the formula PbCl₂.PbO.H₂O, the second the formula PbCl₂.3PbO.H₂O.

The most plausible explanation of this difference of action seemed to be that in the case of the substance heated upon the sand-bath the mixture was kept boiling briskly at the higher temperature; the loss of ammonia was consequently more rapid, and, for a portion of the time, whatever oxychloride had been formed was subjected to the action of a boiling solution of ammonium chloride.

To test the correctness of these results, two equal amounts of the chloride (about 5 grms.) were taken, ammonia solution added, and the two then heated, one upon the sand-bath and the other upon the water-bath. As the one on the sand-bath was kept at a brisk boil, evaporation was faster, and more of the ammonia had to be added to replace that which was thus lost. Hence to the chloride upon the sand-bath 145 c.c. were added, whereas 65 c.c. sufficed for that heated on the water-bath. The object was to keep the ammonia solution strong enough to give always a decided smell of ammonia. Once or twice, however, that upon the sand-bath became very weak.

The residue from the sand-bath mixture was washed. The substance was creamy-yellow, and was unchanged by heating up to 200° C.

- I. 0.5060 gm. of substance gave 0.2745 gm. AgCl.
P.c. Cl = 13.41.
Water-free = 13.89.
- II. 1.2700 grms. of substance gave 1.4730 grms. PbSO₄. P.c. Pb = 78.45.
Water-free = 81.26.

Pb calc. p.c., 82.56	Found p.c.	81.26
Cl ₂ .. 14.13	"	13.89
O .. 3.31	"	

The formula, then, is PbCl₂.PbO.

The residue from the water-bath was much yellower, and became a deep yellow on heating. The analysis gave the following results:—

- I. 0.520 gm. of substance gave 0.1370 gm. AgCl.
P.c. Cl = 6.51.
Water-free = 7.28.

This corresponds with the percentage of chlorine calculated for the tribasic chloride, PbCl₂.3PbO.

For the experiments with the iodide conducted by Mr. Borden, lead iodide was prepared by precipitating pure lead nitrate with pure potassium iodide, and thoroughly washing and drying the precipitate. In the first set of experiments three portions were taken. One was heated on the sand bath ten hours, the second a similar time on the water-bath; the third was covered with ammonia solution, and set aside for three days at a temperature of

15° to 20° C. In the first two instances no precautions were taken to keep a strong solution of ammonia over the iodide. In the analyses lead alone was determined as pointing with sufficient accuracy to the nature of the body formed. Corrections were made for the percentage of water retained in the powders analysed. Generally two simultaneous lead determinations were made of each substance. The means of concordant analyses are given:—

1. Substance heated on water-bath gave 62.50 p.c. Pb.
2. Substance heated on sand-bath gave 60.11 "
3. Substance standing in the cold gave 58.82 "

Calculated for PbI₂.PbO, p.c. Pb = 60.51. Calculated for PbI₂.2PbO, p.c. Pb = 68.45.

From this it would seem that the ammonia which was only moderately heated had the greatest effect; that which was not heated at all had the least.

In the second set of experiments the heating lasted only seven hours (the mixture stood three days before heating), but care was taken to insure a strong solution of ammonia always covering the iodide. The results were as follows:—

1. Substance heated on water-bath gave 64.13 p.c. Pb.
2. Substance heated on sand-bath gave 63.25 "

Another set heated ten hours without previous standing were analysed:—

1. Substance heated on water-bath gave 61.60 p.c. Pb.
2. Substance heated on sand-bath gave 60.37 "

From these results it will be seen that the longer ammonia is allowed to act upon the iodide the more iodine is removed, and hence the more oxide of lead formed. To test this, two portions were taken, and the ammonia allowed to act on one for thirty-eight hours (heating it on the water-bath); on the second sixty-eight hours. The analyses were as follows:—

1. Substance heated 38 hours gave 74.10 p.c. Pb
2. Substance heated 68 hours gave 78.94 "

Calculated for PbI₂.3PbO, 73.26 p.c. Pb; for PbI₂.4PbO 76.38 p.c. Pb; for PbI₂.5PbO, 79.31 p.c. Pb.

These experiments, then, would lead to the following conclusions:—

1. By the action of ammonia in the cold the monobasic oxy-iodide of lead is formed.
2. By heating the solution we get oxy-iodides, the basicity of which is determined by the length of heating. If, by the more active boiling upon the sand-bath, the ammonia solution becomes weak, then the tendency is to form the monobasic oxy-iodide. The oxide of lead previously formed reacts upon the ammonium iodide, forming lead iodide and setting free ammonia.

In the case of the action of ammonia on lead chloride, as examined by Mr. Wood, it seems that the oxychloride formed is not dependent upon the time of heating, but a definite oxychloride is formed whether heated six, ten, or fifteen hours, provided the chloride is kept covered with an excess of ammonia. If, by active boiling on the sand-bath, the ammonia solution becomes too much weakened, then a definite oxychloride is formed, independent of the number of hours the solution is heated. Some of Mr. Wood's experiments were repeated to test these conclusions.—*Journal of the American Chemical Society.*

Influence of Storms on Underground Telegraphic Lines.—M. Mascart.—The author shows that there sometimes occur in telegraph offices supplied by subterranean lines electric discharges which produce sparks. These accidents are much less frequent and severe than in cases where the wires pass over-head, and they do not appear to interfere with the transmission of messages. They always coincide with storms which happen in the country at a distance from towns where underground telegraph wires are protected by the over-lying system of water and gas-pipes.—*Comptes Rendus*, No. 25.

NOTICES OF BOOKS.

A Treatise on the Manufacture of Soap and Candles, Lubricants, and Glycerin. By W. LANT CARPENTER, B.Sc., F.C.S., &c. London: E. and F. N. SPON.

THE demand for treatises on the various branches of applied chemistry seems to be on the increase, and the supply augments accordingly. To produce a manual of this kind which shall not only be free from errors but shall contain all the latest improvements is an exceedingly difficult—if not an impossible—task. It is no easy task to follow even all the inventions which crowd upon each other, and it is often harder still to distinguish between the practicable and the impracticable.

The present work, though largely founded upon its author's contributions to Spon's "Encyclopædia of the Industrial Arts, Manufactures, and Commercial Products," may fairly be pronounced systematic and well arranged. Mr. Carpenter, in his preface, lays claim to having been for several years practically engaged in these industries, and such an acquaintance is manifest throughout the work.

The author begins with an exposition of the principles of the art, and he very properly recommends the practical study of chemistry to all who contemplate entering into the business.

A series of chapters are devoted to the raw materials, both organic and inorganic. First in costliness rank the oils and fats. A peculiarity of the soap trade is that it is comparatively little affected by seasons of general prosperity or depression. People, whatever may be their position, do not buy more soap than they actually need, and it is hence not one of those articles in which economy is attempted in hard times. From these two causes has sprung a tendency to lower the price of soaps to the maker and the consumer by various processes of sophistication, which the author duly notices.

From the section on vegetable oils we learn, by no means with satisfaction, that the consumption of palm-oil for soap making has greatly decreased.

Many facts are given proving that pure oils scarcely exist. Linseed itself is sold in a mixed state. "Previous to the Crimean war it was a recognised custom at the Black Sea ports to add 1 measure of hemp or other seed to every 29 of linseed. Since then the proportion has risen to 1 in 19. On the other hand, the Indian seed is grown mostly as a mixed crop with mustard and colza."

The proximate analysis of the oils and fats is discussed at some length, and some very useful instructions are given on the method of obtaining fairly representative samples. The points which he determines are the moisture in fats; the organic and mineral impurities; the free fatty acids; the total fatty acids in fats not containing glycerides of soluble acids; and the separate determination of oleic acid apart from the stearic and palmitic; glycerin, and unsaponifiable oils.

In determining the specific gravity of oils the author rejects determinations made with the hydrometer, except for the roughest purposes.

The identification of mixed samples of oils he rightly pronounces a point of the greatest difficulty. Among the more trustworthy methods he mentions spectroscopic examination and Maumené's process, *i.e.*, the determination of the rise of temperature produced by mixing fixed volumes of the oil and of sulphuric acid. The bromine process, as worked out by Messrs. Mills and Snodgrass, is favourably noticed. Mr. Carpenter points out the difficulty of getting really genuine standard samples for comparison. "The oil trade is so permeated by the principle of *admixture* that the refiners have too often good reason to shun any attempts to render its detection more easy."

It will be somewhat surprising to many readers to find here an account given in detail of the manufacture of black-ash and even of the disposal of tank-waste. Certain

large soap-boilers, however, are of opinion that they find an advantage in buying salt-cake and converting it themselves into caustic soda, as it is done in the alkali works. We venture, however, to surmise that ready-made caustic soda will ultimately be recognised as the best material for soap making. Concerning the production of caustic from soda-ash, &c., Mr. Carpenter uses an expression which is capable of being misunderstood. He writes that "in America the second process (causticising soda-ash with quick-lime) has been in vogue for many years even in the very largest factories." The author is, of course, aware that the treatment of kelp-ash, barilla, soda-ash, &c., with lime is the old original process everywhere.

In the actual manufacture of soaps the author goes into very full details. He describes the preparation of soap from free fatty acids and alkaline carbonates, the so-called cold process and saponification under pressure, and soft-soaps. For the purposes of the woollen manufacturer the author fully recognises that a genuine neutral potash-oil-soap is the best; that the addition of rosin, the presence of soda, and of alkaline silicates are all objectionable.

We regret to observe that in this portion of the work the author, when speaking of the specific gravity of any solution, gives it first in degrees of Twaddell, and then adds the degree according to Beaumé. We think that the use of the latter instrument should be every way discouraged.

In a quotation from the lecture of Mr. Cross, at the Health Exhibition, we notice a true and humorous remark:—"With fine logic the public came to the conclusion that because Castile soap, which was good, was mottled, therefore all mottled soap must be good." The manufacture of artificial mottled soaps was introduced into England by one Kottula, a German.

Among disinfective soaps particular mention is made of thymol soap. Thymol is said to be non-poisonous, and yet to have about eight times the disinfective power of phenol.

In discussing manufacturers' soaps the author mentions a curious—and typical—case, where a good soap was brought into temporary discredit by the carelessness of the consumer's workmen.

A very ably-written chapter is devoted to the theory of the action of soaps, and to their analysis and valuation.

The remaining portions of this work treat of candle-making, of the separation of glycerin, and of lubricants. Lastly, comes a list of patents bearing upon the manufactures in question, and a bibliography.

This work will prove extremely welcome to technological students, and will be of no small use to a large class of manufacturers who have hitherto practised their art by rule-of-thumb, and have fallen into many errors by neglecting first principles.

Kelly's Directory of Chemists and Druggists. This work includes Manufacturing Chemists, Wholesale Druggists, Drysalers, Patent Medicine Vendors, and other Trades connected therewith, of England, Scotland, and Wales. Fifth Edition. London: Kelly and Co.

WE must confess our inability to understand the principle on which this work has been compiled; that is, why certain professions and trades have been inserted and others excluded. We find here, for instance, the photographers duly enumerated. Why, then, are not the artists given? We have here hospitals, dispensaries, and dentists. To have inserted the medical profession in general would have been merely an additional step in the same direction. As mustard manufacturers, cocoa and cocoatina manufacturers, corn-flour makers, baking-powder makers, essence of coffee manufacturers, &c., find here a place, the manufacturers of pickles, preserved fruits, and condensed milk might just as well have been inserted. The fact is that the volume before us contains the substance of two, if not three, very useful works, which only want separating from

each other. Thus the photographers would very well form a distinct directory, along with artists, sculptors, engravers, lithographers, and designers of all kinds. The hospitals, surgeon-dentists, &c., would find their appropriate place in a medical directory; whilst the makers of cocoa, British wines, champagne powders, and the like might figure in a directory of grocers, provision dealers, restaurants, &c. Each of the works that we suggest would be far more useful for being separated from all incongruous matter.

A more serious fault is that in the "classification of trades" the two categories "London" and "Country" are still kept up. This entails considerable inconvenience. If, for instance, we wish to see a full list of the manufacturers of aniline dyes in the kingdom, we must first turn to page 270 and then to page 395, and in like manner with other trades. We cannot see the slightest advantage of this dual arrangement.

Turning to matters of detail, we find in the index of trades "phosphate of lime merchants and importers," "French Chalk importers," and fuller's earth merchants," but there is no mention of dealers in bauxite, graphite, pyrites, magnesite, vanadium, &c.; nor have we been able to find a list of mineral merchants and brokers.

Under the head "Chemists—Analytical" we find mention of the Society of Public Analysts and of the Chemical Society, but nothing is said of the Institute of Chemistry or of the Society of Chemical Industry. One eminent public analyst is omitted, one analytical chemist who has removed is still given at his old address, and one who has been dead for some time remains on the list.

Under "Chemical Publications" we miss the *Analyst* and the *Journal of the Society of Chemical Industry*, and find instead the *British Journal of Dental Science*, the *Homœopathic World*, and the *Monthly Homœopathic Review*,—publications having no more right to be classed as "Chemical" than, e.g., the *Lancet* or the *British Medical Journal*.

We mention these shortcomings not from any desire to find fault, but because we regret to see flaws in what would otherwise be a very useful work.

The Retrospect of Medicine: being a Half yearly Journal containing a Retrospective View of Every Discovery and Practical Improvement in the Medical Sciences. Edited by JAMES BRAITHWAITE, M.D. Lond. Vol. XCI., January-June, 1885. London: Simpkin, Marshall, and Co.

WE regret to learn from this volume the death of the senior editor, Dr. W. Braithwaite, who founded it forty years ago. The work will be continued by his eldest son, who for a quarter of a century has been associated with him as co-editor.

In a paper by Dr. E. Klein, F.R.S., on the "Influence of Antiseptics on Micro-organisms," we find some very interesting details. It appears that a number of pathogenic microbia refuse to grow in media to which phenyl-propionic acid or phenyl-acetic acid, containing merely 1 part of the antiseptic in 1600 of water, has been added; but if they are placed in much stronger solutions, even 1 in 200, and are then afterwards removed to a suitable nourishing medium, "it is found that they have completely retained their vitality, and they multiply as if nothing had been done to them." From experiments tried by the author in concert with Dr. Blyth it would seem that mercuric chloride is no more a germicide than is pure water. The questions whether any substance is capable of permanently preventing the growth and multiplication of microbia, and still more of destroying their germs, have yet to be answered.

The rest of the contents of this volume, though highly important from a medical point of view, have little direct chemical interest.

List of Tests (Reagents) arranged in Alphabetical Order according to the Names of the Originators. By H. M. WILDER. New York: P. W. Bedford. London: E. and F. N. Spon.

THIS little book is most distinctly a "happy thought." There are now in existence and in use a formidable number of special tests or reagents for different substances. These are often, for brevity's sake, referred to in text-books and in the "Transactions" of societies simply by the names of their originators. It is impossible to remember the composition of each and all, and much time has therefore often to be wasted in a search. Mr. Wilder, to meet this growing difficulty, has collected and described all such tests as have got into use, and arranged them alphabetically under the names of their originators. By so doing he has rendered a very great service to chemists of all kinds, who will soon learn to regard this book as an indispensable laboratory companion.

CORRESPONDENCE.

CAMPHOR MOTIONS.

To the Editor of the Chemical News.

SIR,—Relative to the correspondence on "Camphor Motions" (CHEM. NEWS, vol. lii., p. 23) I think that if Mr. Casamajor will carefully re-examine those facts he will see that the third of these is altogether dependent upon and subordinated to the first two, and that consequently there are but two separate facts.

I see, therefore, no reason for making any amendment in, or any addition to, my original statement.—I am, &c.,

THOMAS HART.

The E.C. Powder Works, Dartford,
July 15, 1885.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. c., No. 24, June 15, 1885.

Spectroscopy by Radiant Matter. Mutual extinction of the Spectra of Yttrium and Samarium.—W. Crookes.—A mixture of 90 parts samaria and 10 parts yttria was treated with sulphuric acid, ignited, and examined in the radiant matter tube. The result was remarkable and unexpected. Not the least trace of the spectrum of yttrium was observed. The pulverulent matter became phosphorescent with a moderate intensity, but the spectrum was almost the facsimile of that given by pure samarium sulphate, the only difference being that the linear orange ray, scarcely visible in the spectrum of pure samarium sulphate, became bright enough to be measured, and occupied the position 2693 on the scale of $\frac{1}{\lambda^2}$. Up to a proportion of 43 parts samaria to 57 parts yttria the spectrum was almost similar to the lead samarium spectrum. Not one of the bands of the yttrium spectrum was perceptible. After this proportion a rapid change set in, and with a mixture of 35 samaria to 65 yttria, the only indication of the spectrum of samarium was the presence of two faint green bands near the lemon-yellow band of yttria, while the new orange ray showed itself as distinct as ever. Thus an abrupt change of the spectrum occurs between very narrow limits on varying

the composition of the mixtures. The spectrum of 44 parts samaria and 56 parts yttria is, save the orange ray just mentioned, the same as that of pure yttria. The spectrum of 42 samaria and 58 yttria is composed of the peculiar bands of both earths, whilst the spectrum of 39 samaria and 61 yttria is almost that of pure yttria. As regards the delicacy of the spectral reaction of samarium, one part of samarium mixed with 100 parts of calcium gives a very brilliant spectrum, but little less definite than a mixture of 50 per cent. With 1 part samarium in 10,000 calcium the second green band is on the point of vanishing and the continuous spectrum of calcium sulphate becomes more brilliant. With 1 part of samarium in 100,000 calcium, the green and the red bands are scarcely visible, but the double orange band is still very apparent, and the black space 2942 between this band and the green is well marked. A mixture of 1 part samarium to 2½ million parts of calcium shows a spectrum in which mere traces of the samarium bands are seen. Its presence is revealed only by the darkening of the yellow region of a spectrum which would otherwise be continuous. The abnormal orange ray 2693 is extremely faint with pure samarium sulphate. With 80 parts samaria to 20 of yttria it reaches its maximum intensity, but with 3 samaria to 97 yttria it begins to fade, but vanishes completely only with pure yttria. As long as this ray forms a part of the spectrum the other bands are evidently less intense when this ray is present than in other phosphorescence spectra in which it is absent. Many of the bands ordinarily present in the spectra of samaria and yttria are also suppressed. The profound modification of these spectra produced by a mixture of these earths is probably a fact unprecedented in spectroscopic analysis. Hence the conclusions drawn from spectral analysis *per se* are open to grave doubts unless the spectroscopist goes hand in hand with the chemist.

Action of Cadmium upon Ammonium Nitrate.—H. Morin.—According to Schœnbein this reaction gives a solution of cadmium nitrite. The author, on reproducing the experiment, finds that the product is a double ammonium and cadmium nitrite, the first instance known of a double crystalline nitrite into the composition of which there enters ammonium nitrite.

Sulphur derived from the Decomposition of Hydrogen Persulphide.—M. Maquenne.—The author, referring to M. Sabatier's paper of May 25th, points out that he had previously obtained tablets of sulphur by the same process (*Bulletin Soc. Chim. de Paris*).

On Sodium Methylete.—M. de Forcrand.—A thermochemical paper. The author investigates the heat evolved on dissolving sodium in anhydrous methylic alcohol, a process which is not attended with ignition, as in the case of ethylic alcohol, though the reaction is more intense.

Volatility in the Chloro-nitriles.—L. Henry.—The propinquity of the chlorine and nitrogen fixed upon carbon in inorganic compounds exerts a considerable influence upon the volatility of the latter. The author establishes this conclusion by means of the chloro-nitriles, giving the result of his observations in the form of tables.

Alleged Elective Fermentation.—M. Maumené.—The author maintains that the fermentation of inverted sugar is effected in a regular manner without any elective feature. He states that inverted sugar is not composed simply of the two sugars glucose and levulose in equal equivalents. The proportion of these two bodies is very far from equality, and there is present a third, and even a fourth body, the characters of which have not been definitely ascertained, but whose existence is proved by the action of lime on inverted sugar. Fermentation is disturbed by the resistance of these two bodies to alcoholic fermentation, properly so called.

No. 25, June 22, 1885.

New Models of Hygrometers.—M. Bourbouze.—This paper, when read, was accompanied by a display of

the instruments, without which their construction is not clearly intelligible.

An Arrangement for obtaining without Calculation the Magnetic Potential due to a System of Coils.—G. Lippmann.—This paper does not admit of useful abridgment.

Transformation of Sulphur.—J. H. Van't Hoff.—A claim of priority on behalf of MM. Reicher and Ruys, as against M. Gernez.

Alkaloids produced by the Action of Ammonia upon Glucose.—C. Tanret.—The author finds that not merely ammonia, but the compound ammonias, produce alkaloids if heated with glucose. By the action of ammonia he thus obtains α -glucosine, $C_{12}H_{18}N_2$, boiling at 136° , and β -glucosine, $C_{14}H_{20}N_2$, boiling at 160° . Both the glucosines are very volatile, mobile liquids, colourless, refracting light strongly, of a peculiar odour, and without action upon polarised light. Both, in acid solutions, are precipitated by the double potassium and mercury iodide, tannin, bromine-water, &c. They reduce potassium ferricyanide slowly. With hydrochloric acid they form crystalline hydrochlorates; with gold chloride two canary-yellow precipitates, and with platinum chloride a mixture of variously-coloured salts, which have not yet been separated.

Action of Seleniates and Selenites upon the Alkaloids. A New Reaction of Codeine.—Ph. Lafon.—If a trace of codeine is treated with ammonium selenite in a sulphuric solution (ammonium selenite 1 part; sulphuric acid, full strength, 20 parts) there appears a splendid green colouration. The reaction may be obtained with less than $\frac{1}{10}$ milligram of codeine. No other alkaloid produces this reaction; morphine might be most easily confounded with it, but is at once distinguished by its numerous peculiar reactions.

On Aseptol.—E. Serrant.—This compound, orthoxyphenyl-sulphurous acid, has been known since 1841, but its antiseptic properties have been overlooked. The corresponding para- and meta-acids have no antiseptic action.

Bulletin de l'Association des Elèves de M. Fremy.
2nd Series, No. 3, July, 1885.

Emission of Carbonic Acid and the Absorption of Oxygen by Leaves kept in Darkness.—P. P. Dehérain and Maquenne.—The authors observe that in *Euonymus japonica*, the plant selected for experiment, the carbonic acid given off exceeds the oxygen absorbed. Thus the respiratory phenomena of leaves consist not merely in a transformation of the oxygen absorbed into carbonic acid, but also in the production of carbonic acid from internal consumptions similar to those which take rise in fermentations.

Simultaneous Action of Oxygen and of Hydracids upon Selenio-urea.—A. Verneuil.—The author describes a compound which takes rise when oxy-tri-selenurea hydrochlorate is exposed for a length of time to the air. He considers that this compound is not a chlorinised addition-product, but as the combination of a selenurea dihydrochlorate with 1 equiv. of selenurea.

Ammoniacal Copper Sulphate and a Basic Copper Sulphate.—G. André.—The author passes for a long time a strong current of ammoniacal gas into a saturated solution of copper sulphate strongly refrigerated. On sufficiently prolonging the action of the ammoniacal gas all the copper is precipitated, and the liquid is almost colourless. Ammoniacal copper sulphate is therefore insoluble in strong ammonia. If ammoniacal copper sulphate, water, and metallic copper are gently heated together in a flask communicating with the atmosphere merely by a tube drawn out to a point, the copper blackens, and there is deposited on the sides a scanty coating of black oxide, which gradually turns apple-green. If the

liquid is decanted and brought in contact with fresh copper, the green coating alone is deposited. If it is dried at 100° it has the composition of a basic copper sulphate.

Parchmented Filter-Paper.—Mr. Francis.—From the *Journal of the Chemical Society*.

Apparatus for Liquefying Oxygen.—This paper requires the accompanying figure.

Study on the Fermentation in Indigo Vats and on the Constitution of the Theoretic Vat.—Lucien Benoist.—An examination of the part played in the chemistry of the fermentation vat by microbia. The author gives means for isolating a desmobacterium the action of which in the vat is desirable, and for eliminating other and injurious ferments. We shall, if possible, insert this paper *in extenso*.

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Bulletin de la Société Chimique de Paris.
Vol. xliii., No. 11, June 5, 1885.

Chemical Neutrality of Salts, and the Use of Colouring Matters in the Determination of Acids.—M. Berthelot.—Already noticed.

Speed of the Propagation of Detonation in Explosive Matters, Solid and Liquid.—M. Berthelot.—Already noticed.

The Ideas of the Alchemists.—M. Berthelot.—Already noticed.

Researches on Isomerism in the Aromatic Series: Neutralisation-heat of the Polyatomic Phenols.—MM. Berthelot and Werner.—Already noticed.

Bromo-substitutions of the Polyatomic Phenols.—MM. Berthelot and Werner.—Already noticed.

Reaction of Bromine upon the Chlorides and on Hydrochloric Acid: New Class of Perbromides.—M. Berthelot.—Hydrochloric acid and very concentrated chlorides dissolve bromine in considerable quantity and with the liberation of heat, a circumstance which attests the existence of certain addition-compounds, the perbromides of the chlorides.

Pathological Urines.—A. Villiers.—Already noticed.

The Action of Ammonia upon Solutions of Potassium Salts.—H. Giraud.—Most potassium salts are less soluble in water charged with ammonia than in pure water. Some, such as the sulphate, oxalate, ferrocyanide, and phosphates, are partially precipitated if to their saturated solutions there is added a saturated solution of ammonia. Others, such as the chloride, nitrate, and chlorate, are not precipitated if their saturated solutions are saturated with ammonia. If a very strong solution of potassium carbonate is saturated with ammonia there are formed two strata: the upper layer contains the bulk of the ammonia, whilst the lower contains nearly all the potassium carbonate. Of all the potassium salts the least soluble is the sulphate. Potassium solutions so dilute as not to be precipitated by acid sodium tartrate, nor by platinum tetrachloride (without the addition of alcohol), give an abundant precipitate if they are first saturated with gaseous ammonia, and then mixed with an ammoniacal solution of sodium sulphate.

Preparation of Cyanogen in the Moist Way.—G. Jacquemin.—Already noticed.

Determination of Cyanogen mixed with other Gases.—G. Jacquemin.—Already noticed.

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Journal de Pharmacie et de Chimie.
Series 5, Vol. xi., No. 12, June 15, 1885.

Pepper and Olive Kernels.—G. Planchon.—A notice of the adulteration of pepper with olive-kernels, and of the means for their detection. None of the morphological elements of pepper can be confounded with the elements of the olive-kernel. The characteristic features of the

two are perfectly distinct. The several kinds of pepper, (those of Tillechery, Sumatra, Saigon, &c.), resemble each other completely in structure.

Formation of Alkaloids in Diseases.—M. Villiers.—Already noticed.

Curarine of *Strychnos toxifera*.—M. Villiers.—The author has not succeeded in obtaining curarine in a state of purity. It has always been contaminated with extractive matter, which is simultaneously precipitated by the reagents employed.

Action of Chlorine on Isobutylic Alcohol.—H. Boquillon.—However long the action of the chlorine be continued, mono-substituted derivatives only are obtained.

Titration of Potassium Iodide with Iron.—E. Falières.—This paper will be inserted in full.

Is Tuberculosis Transmissible by Vaccination?—J. Straus.—The author's conclusion is practically negative.

Lakmoid regarded as an Indicator.—M. Traub.—The limit of sensibility of lakmoid for ammonia is 1 part in 200,000. With dilute hydrochloric acid litmus and lakmoid are equally sensitive. In the volumetric determination of alkaline carbonates the expulsion of the carbonic acid is as necessary with lakmoid as with litmus.

Reactions of Menthol.—Menthol dissolves readily in twice its weight of chloroform. A small quantity of iodine produces, gradually, a fine indigo colouration, which disappears on the addition of caustic potash or soda. To recognise the presence of thymol in menthol pencils we add to 1 part of the sample 4 parts strongest sulphuric acid. If thymol is present the mixture becomes yellow, and turns rose-coloured on heating. Menthol dissolved in chloroform or alcohol is turned a reddish violet by solution of potash if it contains thymol.

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Cosmos les Mondes.
No. 19, June 8, 1885.

It appears that in French manufacturing establishments where steam-power is used one workman out of every 4 or 5 is injured yearly, and that of 200 such cases one proves fatal.

No. 20, June 15, 1885.

Manufacture of Gunpowder.—M. Nordenfelt proposes to dissolve the sulphur in carbon disulphide, incorporate it with cellulose reduced to an impalpable powder, in place of charcoal, and finally to add the saltpetre as a saturated solution. During the process of desiccation the mass has to be stirred to prevent the formation of crystals. (Is the carbon disulphide recovered?)

No. 21, June 22, 1885.

This issue contains no chemical matter.

MISCELLANEOUS.

South London School of Pharmacy.—The following prizes were awarded at the school examinations held from the 1st to the 4th of July, 1885:—Senior Chemistry—Medal: Francis W. Taylor; Certificate, John B. Nichols. Junior Chemistry—Medal: Andrew Craig; Certificate, Alfred L. Wood. Botany—Medal: John B. Nichols; Certificate, Ernest L. Ralling. Materia Medica—Medal: John Tirrell; Certificate, J. Burgess. Pharmacy and Practical Dispensing—Medal: Robert Pyle; Certificate, John W. Carr. Extra Certificates of Merit to Messrs. Jackson, Lewis, Minter, Moore, and G. H. Taylor.

TO CORRESPONDENTS.

V. A. Latham.—We have not found anything capable of bleaching the colour. Many reagents act partially, but none sufficiently well.

THE CHEMICAL NEWS.

VOL. LII. No. 1340.

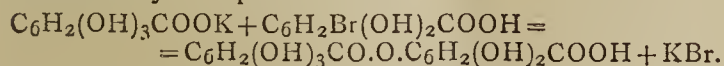
DECOMPOSITION OF DIDYMIUM.

At the meeting of the Vienna Academy of Sciences on June 18th Dr. C. A. v. Welsbach sent in a paper on the decomposition of didymium into its elements. This decomposition was effected by means of the double ammonium or sodium nitrates in presence of lanthanum. In spite of the different behaviour of the constituent bodies many hundred fractionated crystallisations were necessary for their separation. The two new elements in solution are distinguished by intense absorption-bands, and share between them the absorption-bands of the peculiar spectrum hitherto ascribed to didymium. The two new elements when mixed in proper proportions display the colour and spectrum of didymium. The spark-spectra are brilliant and characteristic, and are parts of the spark-spectrum of didymium. The colour of the compounds differs. The salts of that element which approaches nearest to lanthanum are of a leek-green. The salts of the other element are rose or amethyst-red. The latter body forms the bulk of didymium. Both colours are almost complementary, but the amethyst-red is by far the more intense, so that the presence of a few per cents of the salts of this element in the compounds of the other suffices to make its green colour disappear. The atomic weights of the two new elements are, according to preliminary determinations, very different and vary considerably from the value heretofore ascribed to didymium. For the first element the author proposes the name praseodym, Pr, and for the second neodym, Ne. The two elements, as far as it has been observed, yield each only one series of salts derived from the sesquioxide. Praseodym peroxide evolves chlorine on treatment with hydrochloric acid.—*Chemiker Zeitung*.

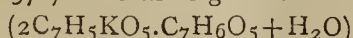
PRELIMINARY NOTE ON THE SYNTHESIS OF TANNIN.

By BERTRAM HUNT, Leeds.

It having been shown, lately, by Böttiger and others that Schiff's digallic acid differs from gallo-tannin, and is probably only isomeric with it, it occurred to me that possibly gallo-tannin might be produced by the action of mono-bromo-protocatechuic acid on potassic gallate. The reaction may be represented thus:—



The experiment was done as follows:—Mono-bromo-protocatechuic acid was prepared by the action of excess of bromine on protocatechuic acid in the cold ("Watt's Dictionary, vi., 976). Potassic gallate—



was prepared according to the directions given in "Watt's Dictionary," ii, 761.

The bromo-protocatechuic acid and potassic gallate were cohobated together on the water-bath for about five hours in presence of absolute alcohol, a slight excess of potassic gallate being used. The cold liquid was filtered through fine asbestos, and the alcohol evaporated off at a low temperature. The residue was dissolved in aqueous ether, and the solution filtered through asbestos. The ether was now evaporated off, and the residue dissolved in cold distilled water. The filtered, brown-coloured solu-

tion gave the following reactions:—It precipitated gelatin solution. It precipitated cupric acetate solution, and the precipitate was insoluble in ammonic carbonate. It gave a precipitate with tartar emetic solution in presence of ammonic chloride. It gave a black colour with ferric chloride, and, on standing some hours, a slight black precipitate. It reduced Fehling's solution readily on boiling. It precipitated cinchonine sulphate solution. The cinchonine precipitate was washed and carefully dried. The amount of cinchonine in it was determined by dissolving a weighed quantity in dilute sulphuric acid, boiling, and then precipitating the cinchonine in the cooled solution by a slight excess of caustic soda. The result was 31.56 per cent cinchonine in the dry precipitate. $\text{C}_{20}\text{H}_{24}\text{N}_2\text{O}_2 \cdot 2\text{C}_{14}\text{H}_{10}\text{O}_9$ gives 32.353 per cent cinchonine.

These reactions are identical with the reactions of gallo-tannin and are not given by either gallic or protocatechuic acid, or by a mixture of these acids. Further experiments are of course required to prove the identity of the substance produced with gallo-tannin.

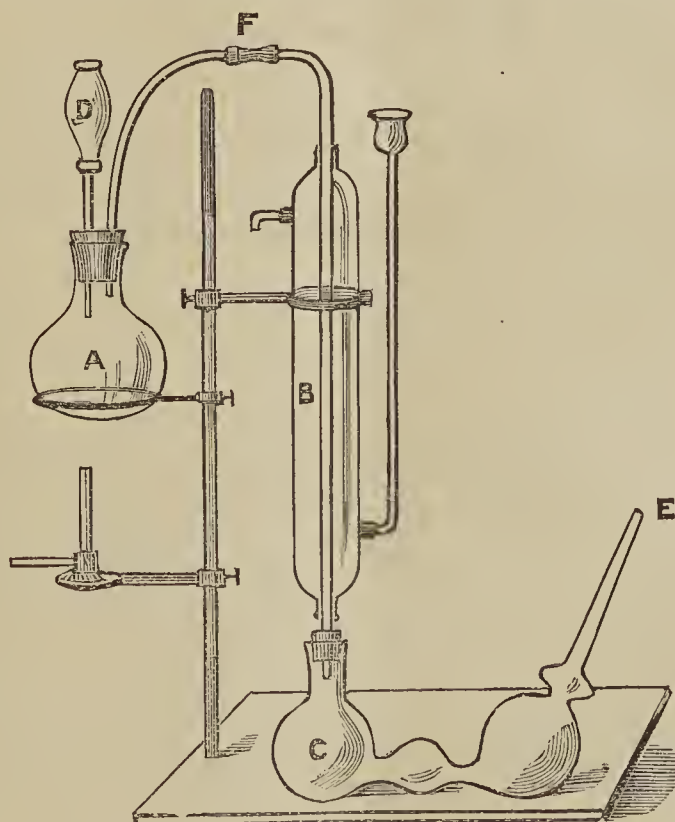
July 20, 1885.

A CONVENIENT FORM OF APPARATUS FOR THE DETERMINATION OF AMMONIA BY DISTILLATION.

By F. G. HOLMES, F.C.S.

THE following drawing shows the arrangement of the apparatus:—

In the figure A is the distilling flask, 8 c.m. dia.; B, the condenser; and C, the absorbing bulbs (5 c.m. dia. each bulb).



In the analysis of sulphate ammonia weigh 0.5 gm. from the well-mixed sample, and wash off the weighing glass into the flask A, with about 20 c.c. of distilled water; 25 c.c. of decinormal sulphuric acid are then measured into the bulbs C, and the two connected with the condenser; a gentle heat is applied to the flask, and a little water distilled over, in order to drive out as much air as possible. About 10 to 15 c.c. of 20 per cent caustic soda solution are placed in the stop-cock funnel, D, and a sufficient quantity

run into the flask to cause a slow stream to bubble through the acid, which ceases when all the air is eliminated. The alkali may then be gradually added. When the alkaline liquid in the flask becomes rather concentrated, a little distilled water is run in at D, and distilled over; this addition of water can be repeated if thought necessary, as it assists in washing out the condensing tube. The distillation being stopped, the free limb, E, of the bulbs, is connected with an aspirator, and air drawn through the apparatus; the tube is then disconnected at F, and well washed with distilled water into the bulbs, C; the acid is titrated in the usual way. I have found the above apparatus very convenient, and have obtained very accurate results by it; I thought therefore that a description of it might be of some service to those engaged in the analysis of ammoniacal salts, &c.

July 16, 1885.

ON THE MOTIONS OF CAMPHOR ON THE SURFACE OF WATER.

By CHARLES TOMLINSON, F.R.S.

WHEN anyone writes on a scientific subject without first making himself acquainted with what has already been accomplished by previous investigators, he runs the risk of wasting his own time and that of his readers, while he occupies space in a journal that might be more usefully employed.

Had Mr. Hart (CHEM. NEWS, vol. li., p. 277) properly studied his subject, he could not have been led to the conclusion that the motions of camphor on the surface of water are due to the adhesion of the camphor to the liquid, and that whatever increases such adhesion increases the rapidity of the motions.

A bit of camphor on a very thin raft of mica may be placed on the surface of water, and the raft will float about with great activity. I have known such a raft to maintain its motions during a whole week on the surface of water contained in a chemically clean glass vessel $3\frac{1}{2}$ inches in diameter. In such a case there is no adhesion between the camphor and the water, and yet the camphor motions are maintained until, in fact, the camphor has evaporated.

Fragments of camphor also rotate on pure dry mercury. Here the disintegration by solution, which Mr. Hart so much insists on, is wanting, as adhesion is in the former case.

Mr. Casamajor (CHEM. NEWS, vol. li., p. 109) does not seem to have mastered his subject much better than Mr. Hart. He remarks that these motions "are not to be seen at all times. Very often camphor will remain motionless, while at other times the pieces gyrate with great animation." Now there is no reason why the camphor fragments should not always gyrate with great animation, provided the essential conditions on which the motions depend be complied with, viz., chemically clean water in a chemically clean vessel. Nor does he seem to be aware of the fact that a clean finger dipped into the water will not arrest the motions, any more than pure freshly-distilled volatile oils. The fragments of camphor skate through and plough up the films of such oils. I explained this and a variety of cognate phenomena in the pages of this journal some two and twenty years ago (vol. viii., pp. 28, 37, and 123; also vol. x., p. 325).

With regard to the fixed oils, I have explained elsewhere how that the early observers (Volta, Prevost, Venturi, and others), knowing nothing of chemically clean materials any more than of the surface tension of liquids on which these motions really depend, expressed their astonishment at the sudden arrest of the camphor motions when the water was touched with a pin previously dipped in oil. One says that the fragments seem as if struck by

lightning (*comme foudroyés*); another, "struck motionless as if by magic." Now in the writings of these early observers there is nothing to show that they were aware of the necessity of using chemically clean materials, so that the initial tension of the water not being at a maximum, contact with a very slight portion of greasy or oily matter would so far lessen it as to produce the sudden effects described. But if the experiment be repeated under the most favourable conditions in which the surface-tension of the water is at a maximum, the water may be touched with a fixed oil, and the iridescent film resulting therefrom, though lowering the tension, will not do so to a sufficient amount to arrest the motions of the camphor fragments. For example, a shallow glass vessel, 4 in. in diameter, was filled first with strong sulphuric acid, and then well rinsed out with tap-water, and filled with the same. The fragments of camphor were extremely active on the surface, which was now touched with a point that had been dipped into refined rape oil. A film of a deep blue colour was produced, which opened into a kind of lace pattern; but the fragments of camphor continued to rotate. If a drop of a fixed oil be deposited on the surface of the water from the end of a glass rod, it will completely cover the surface and arrest the camphor motions, but there is sufficient tensile force left to give motion to creosote. A drop of this instantly repels the oil film, moves over the surface with great vigour, and cuts up the oil film in all directions.

In the year 1869 Professor Van der Mensbrugghe, of the University of Ghent, published a masterly memoir on the surface-tension of liquids, which was *couronné* by the Royal Academy of Sciences of Belgium, a tolerably full account of which was given by me in the *Philosophical Magazine* for December, 1869, and January, 1870. In this memoir the author garners in facts from all the points of the compass, and accounts for them in the most complete and satisfactory manner on the principle of surface-tension. I cannot encroach further on the space of this journal than by stating this general proposition with which the talented author starts, viz.:—When on the surface of a liquid, A, we deposit a small fragment of a solid, B, which is more or less soluble in A, or detaches from its surface matter that is so, the equilibrium of the superficial layer of A is disturbed. If the solution take place equally all round the fragment this does not move; if unequally, as in different azimuths, the fragment displays sudden movements of translation and rotation.

After the correspondence between Mr. Casamajor and myself in the CHEMICAL NEWS at the end of 1877 and at the beginning of 1878, in which he was referred at greater length than I have now ventured to do to Professor Mensbrugghe's memoir, I could scarcely have supposed him capable of producing so crude a paper as that recently given in these pages. I do not ask him or Mr. Hart to adopt the surface-tension theory, but only to study it; and having done so, I venture to think that if they again write about the camphor motions their work will be greatly improved.

But should Mr. Casamajor reply that his leading experiment has not been noticed, he may be informed that Professor Mensbrugghe has found that the enlargement of any surface increases its tension; hence, after having plunged a glass tube into water covered with lycopodium, on withdrawing it, the portion of liquid which wets the tube produces a general augmentation of tension in the free surface; hence the dust on this surface is attracted by the wetting layer, and is gradually raised on repeating the operation sufficiently often.

It is curious to notice how frequently the camphor motions crop up in popular journals. One writer who had revived long since exploded views, on being referred to the surface-tension theory, replied that this was too academic for his purpose; he only meant to give a popular view. This is just as if adulterated food were fit for the people, and wholesome food only for the members of Academies.

Highgate, N., July 25, 1885.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY
SAMPLES OF THE WATER SUPPLIED TO LONDON
FOR THE MONTH ENDING JUNE 30TH, 1885.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London
Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner,*
Metropolis Water Act, 1871.

London, July 6th, 1885.

SIR,—We submit herewith the results of our analyses
of the 182 samples of water collected by us during the past
month, at the several places and on the several days indi-
cated, from the mains of the seven London Water Com-
panies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of
samples, one taken daily from June 1st to June 30th
inclusive. The purity of the water, in respect of organic
matter, has been determined by the Oxygen and the
Combustion processes; and the results of our analyses by
these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several
samples of water, as determined by the colour-meter
described in a previous report.

In Table III. we have recorded the oxygen required to
oxidise the organic matter, and the quantities of free
oxygen present in the whole of the samples submitted to
analysis.

Of the 182 samples examined, the whole were found to
be perfectly clear, bright, and well-filtered.

In contrariety to what is usually observed in the month
of June, and probably as an effect of the occasional stormy
rainfall occurring in the early part of the month, there was
a slight increase in the proportion of organic matter present
in the water supply of last month, beyond the very small
proportion met with in the preceding month; but the
freedom of the water from colour and turbidity remained
unaffected.

During the past six months we have examined and re-
ported on 1049 samples of the water supplied to the
metropolis; and with the exception of two samples taken
after heavy rainfall in February, and noted at the time as
"very slightly turbid," the whole were found to be well-
filtered, clear, and bright. The mean quantity of organic
carbon present in the Thames-derived water examined
during the six months was 0.153 part in 100,000 parts of
the water, corresponding to just over a quarter of a grain
of organic matter per gallon. In six samples only, taken
in the months of February and March, did the organic
carbon exceed 0.20 part in 100,000 parts of the water;
while the maximum quantity present in any one sample
amounted to 0.256 part, corresponding to less than half a
grain of organic matter per gallon.

We are, Sir,

Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

Production of Crystalline Magnesium Hydrate
(Brucite) and Crystalline Cadmium Hydrate.—A. de
Schulten.—It is generally assumed that magnesium and
cadmium hydrates are absolutely insoluble in alkalies.
The author finds that these hydrates dissolve in a notable
quantity in strong solutions of caustic potash at a high
temperature. When this solution cools the hydrates are
deposited in well-defined crystals.—*Comptes Rendus*, vol.
ci., No. 1.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from p. 43).

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
|| Following a date signifies publication discontinued.

JAHRBUCH (NEUES) DER PHARMACI*. See *Berlinisches Jahr-
buch der Pharmacie*.

97. JAHRBUCH FÜR ÖKONOMISCHE CHEMIE UND
VERWANDTE FÄCHER. Eine Sammlung des
Wichtigsten aus der landwirthschaftlichen Chemie,
den mit derselben verwandten landwirthschaft-
lichen Gewerben und der Hauswirthschaft.
Herausgegeben von Wilibad Artus. 3 vols., 8vo.
Leipzig, 1847-'49.
98. JAHRESBERICHT DER AGRICULTURCHEMIE. Separat-
Ausgabe des Centralblattes für Agriculturchemie
und rationellen Wirthschaftsbetrieb. Heraus-
gegeben von W. Detmer. 2 vols., 8vo. Berlin,
1875. ||
Cf. Centralblatt für Agriculturchemie.
99. JAHRESBERICHT ÜBER DIE FORTSCHRITTE AUF DEM
GEBIETE DER REINEN CHEMIE. Bearbeitet im
Verein mit mehreren Fachgenossen und heraus-
gegeben von Wilhelm Staedel. 1873-'82. 10 vols.,
roy. 8vo. Tübingen, 1874-'84+
100. JAHRESBERICHT ÜBER DIE FORTSCHRITTE DER AGRI-
CULTURCHEMIE, mit besonderer Berücksichtigung
der Pflanzenchemie und Pflanzenphysiologie.
Herausgegeben von Robert Hoffmann. 1856-'64.
6 vols., 8vo. Berlin, 1860-'65.

Continued under the title :

- [a] Jahresbericht über die Fortschritte auf dem
Gesamtgebiete der Agriculturchemie.
Fortgesetzt von Edward Peters. [From
186*, edited by Th. Dietrich, H. Hellriegel,
J. Flittbogen, H. Ulbricht.] 14 vols. (vii.-
xx.), 8vo. Berlin, 1864-'77.
Neue Folge. von A. Hilger. 5 vols. (xxi.-
xxv.). Berlin, 1878-'83+

From 1874, annual volumes are divided
into portions having independent pagi-
nation and bearing the following titles :

- Jahresbericht über die Fortschritte der Chemie
des Bodens, der Luft und des Düngers.
Herausgegeben von Th. Dietrich.
- Jahresbericht über die Fortschritte der Chemie
der Pflanze. Herausgegeben von J.
Flittbogen.
- Jahresbericht über die Fortschritte der Chemie
der Thiernahrung und der chemischen Tech-
nologie der landwirthschaftlichen Neben-
gewerbe. Herausgegeben von J. König und
A. Hilger.

General-Register über Jahrg. i.-xx., [1858-'77].
Unter Mitwirkung von E. von Gerichten, C.
Krauch, E. von Raumer, W. Rössler und O.
H. Will. Herausgegeben von A. Hilger.
1 vol., 8vo. Berlin, 1879.

(To be continued).

* Advance-proofs from the *Annals of the New York Academy of
Sciences*.

THE BIOLOGICAL EXAMINATION OF WATER.

By C. J. H. WARDEN, Surg. H.M.'s Bengal Army,
Professor of Chemistry, Calcutta Medical College.

In the Reichs Gesundheits Amt, Berlin,—where, through the courtesy of Prof. Koch, the late Director, I have been permitted to study for some months,—a large number of water analyses are made, special importance being attached to the bacteriological examination. The late Dr. Angus Smith, of Manchester, has described in the *Sanitary Record* a method of examining water for the presence of micro-organisms, based upon Dr. Koch's earlier researches, but the system now in force in the Laboratories of the German Imperial Board of Health differs materially. It is not a mere qualitative examination for the detection of micro-organisms, but one by which an approximate determination of the number present is attained, and it may therefore perhaps be of interest if I describe at length the *technique*.

In England, unfortunately, at the present time there is no institution where Medical Officers of Health and others can receive instruction similar to that afforded at the Gesundheits Amt, Berlin; and in this communication I assume that the reader has had no previous experience with recent methods of bacteriological research. I have, therefore, thought it advisable to enter rather fully into minutiae which otherwise might have been omitted. Success in bacteriological work is largely dependent upon close attention to details: the methods are simple, but their correct performance is often from this cause difficult of attainment. The rôle which micro-organisms play in the causation of disease is year by year becoming better defined; and the water analyst who wishes to be abreast of the times cannot now confine his attention solely to the "organic" and "mineral" constituents of a water, his attention must also be directed to the *organised*; and not so much to the larger organisms, visible to the naked eye, but to the smaller forms, the Bacterium and other allied species. The importance of examining a potable water for micro-organisms cannot be over-estimated. There is abundant evidence to justify the belief that the germs of at least two diseases—cholera and typhoid fever—are frequently conveyed by water. The addition of one drop of a cholera stool to a litre of sterilised water would form a mixture which, if examined by the Wanklyn, Frankland, or any other chemical method, would yield absolutely negative results. The analysis of a stronger mixture would show the presence of so much "free" and "albumenoid ammonia," or "organic" carbon and "nitrogen," but beyond that no information would accrue. The bacteriological examination would, on the other hand, in either case, with absolute certainty demonstrate the presence of a comma-shaped micro-organism, while subsequent cultivation experiments would indicate whether the organism was the cholera bacillus or not. I do not wish it to be understood that I consider the chemical examination of a potable water useless: the bacteriological test is not by any means intended to supersede chemical methods; it is only an additional test, but one supplying information which a chemical analysis does not afford.

Briefly, Prof. Koch's method consists in adding a measured volume of water to sterilised liquid meat peptone gelatin, which is then poured on a glass plate, and after a certain period the developed colonies of micro-organisms counted, examined microscopically, and, if necessary, cultivated in various media and under different physical conditions. In describing the method I propose first giving a list of the apparatus required; (2) method of preparing the reagents; (3) precautions to be adopted in the collection of samples of water; (4) analytical process; (5) inferences to be drawn from the results.

I. Description of Apparatus.

The apparatus used for the bacteriological examination of water are simple, and with a few exceptions are to be

found in every chemical laboratory. The only expensive instrument is the microscope; the remainder are all inexpensive.

Test-tubes.—The most suitable size is 160×15 m.m. The tubes are employed for containing the gelatin solution, and are prepared for use in the following manner:—They are rinsed with a small amount of strong hydrochloric acid, and thoroughly washed with water, care being taken to remove all trace of acid. The tubes are inverted, and allowed to drain and dry. When quite dry they are plugged moderately tight with cotton-wool. The plug should extend about three-quarters of an inch within, and the same distance beyond the mouth. The tubes are then packed in a *wire basket* (Fig. 1), with the plugged mouths upwards, and placed in a *hot-air bath* (Fig. 2),

FIG. 1.

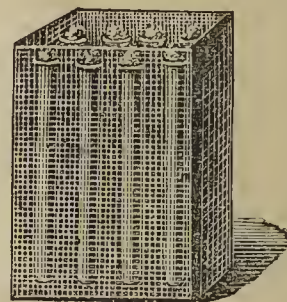
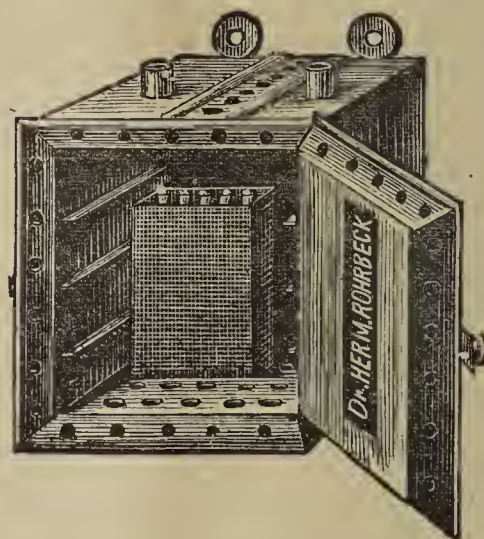
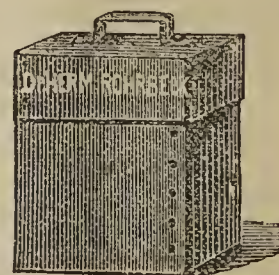


FIG. 2.



which should be heated to 150° to 160° C. for one hour and a-half. This temperature slightly browns the plugs, and is sufficiently high to destroy any germs which may have adhered to the interior of the tubes or to the plugs. After the lapse of the prescribed time the burner should

FIG. 3.



be extinguished, and the tubes allowed to cool in the oven with the door closed: when cold they can be removed from the cage and preserved in a box, care being taken to avoid disturbing the plugs.

Pipettes to hold 1, 2, and 3 c.c., and also to hold 1 c.c., divided into one-tenth and one-fifth of a c.c., are used to

measure the water. They are sterilised by being heated in the air-bath to 150° — 160° C. for one hour and a half, and are then allowed to cool in it, and removed for use as required. Several pipettes should be provided, as a freshly sterilised one is requisite for each sample of water tested. It must be remembered that a pipette once sterilised will not remain germ-free for any time, though not removed from the bath in which it has been heated. The most convenient procedure is to daily heat the requisite number of pipettes required.

Glass rods of about 2 c.m. in length are used for spreading the liquefied gelatin on the plates, &c. They are sterilised in the same manner and at the same time as the pipettes.

Glass plates of flat crown-glass free from flaws, 13×10 c.m. in size, are used for receiving the gelatin film. The sharp edges should be ground down, and the plates then carefully freed from grease, rinsed with hydrochloric acid, and thoroughly washed. When dry they are placed in a copper or sheet-iron box (Fig. 3) provided with a tightly-fitting cover, which is closed, and the box heated in the air-bath for two hours to 150° — 160° C. When cold the box is removed from the bath, and provided care be taken in the removal of a plate the glasses will remain fit for use for several days.

In removing a glass plate the box should be held

wet blotting-paper is to keep the air in the interior of the vessel saturated with moisture, and the paper on the cover also prevents any drops of condensed moisture from falling on the plates. Should the cover fit into and not rest on the surface of the receiver, as in Fig. 5, care should be taken that the blotting-paper at the bottom does not project beyond the edge of the cover, else that portion of the paper exposed to air would dry rapidly, and by capillary action remove moisture from the central parts of the paper. These glass chambers are capable of holding five to six glass plates with benches. Glass chambers, though convenient, are somewhat expensive, but fortunately admit of being replaced by ordinary soup-plates. The soup-plates for this purpose should, if possible, be of two sizes, the one used as the receiver being deeper and larger than the one used as the cover. The soup-plates are prepared for use in precisely the same manner as the glass receivers and covers, and they are capable of holding three plates and benches.

In pouring the liquefied gelatin on a plate after admixture with the sample of water, it is requisite that the plate should be supported on a level surface; and, secondly, that there should be some contrivance by which the gelatin film may be exposed to a low temperature to accelerate the setting. These desiderata are attained by use of the following apparatus (Fig. 7). A consists of a tri-

FIG. 4.



horizontally, a plate slipped out, and the cover at once replaced. If a plate has not been recently sterilised it is advisable to again heat it, by holding one corner with a pair of crucible tongs, and rapidly passing both sides several times through a flame, so as to thoroughly heat every part. It is then placed under a bell-jar to cool, supported on a beaker or other convenient support. A warm plate must never be placed on the levelling apparatus (Fig. 7) or it is almost certain to crack.

Dr. H. Rohrbach, of 100, Friedrich-strasse, Berlin, manufactures glass plates, with a slightly raised square ridge in the centre, 9×9 c.m., into which the gelatin, after admixture with the water, is poured. These plates can be sterilised either in the hot-air bath or by direct application of a flame, without the ridge cracking. They are useful for water analysis, as the gelatin can be accurately spread over the required surface.

A box similar in construction to Fig. 3 may be employed for holding the pipettes and glass rods during sterilisation.

Glass benches (Fig. 4), consisting of a piece of sheet-glass, 13×10 c.m., with two slips of thick plate-glass fixed at the ends by means of sealing-wax, are used for supporting the glass plates after they have been coated with gelatin. Before being used the benches are washed with a solution of aqueous corrosive sublimate, 1 to 1000, and allowed to drain.

The coated gelatin plates, supported on the glass benches, are placed in a moist chamber for development of the bacterial colonies. In the Gesundheits Amt, glass vessels (Figs. 5 and 6) are used. They are prepared for use by being well rinsed with sublimate solution. A piece of thick circular blotting-paper is then fixed in the cover, and two or more layers on the bottom of the receiver, which are well wetted with sublimate solution, and the superfluous liquid allowed to drain off. The object of the

angle of either metal or wood, provided with three levelling screws. The triangle supports a thick glass plate, B, on which rests a circular glass vessel, C, with the rim ground perfectly flat. The glass receiver is about one-half filled with small lumps of ice, and water added to overflowing. A sheet of thick plate glass, D, is then pushed over the surface in such a manner that the iced water is in actual contact with the under surface of the plate. A small circular spirit-level is now placed on the centre of the plate,

FIG. 5.

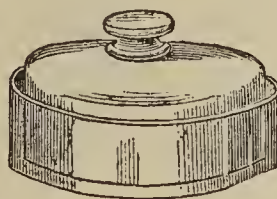
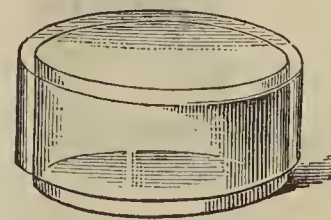


FIG. 6.



and the apparatus levelled by means of the adjusting screws. In using the apparatus, the glass plate which is to receive the liquefied gelatin is placed on the plate D, and after the gelatin has been poured on it, it is covered with the bell-jar, E, until the gelatin has solidified.

The apparatus may be advantageously modified by substituting for the glass plate, B, a shallow vessel into which the receiver, C, fits loosely, and is supported on three pieces of cork. This outer vessel serves to receive the overflow water, and any moisture which may condense on the sides of the vessel which contains the ice. A good microscope, with one-twelfth oil immersion, and preferably Abbé's illuminating apparatus, is necessary. The instrument, made by Zeiss, of Jena, can be thoroughly recommended.

The sterilisation of meat peptone gelatin, &c., is best accomplished by steam at 100°C . in the apparatus Fig. 8, which consists of a metal vessel $\frac{1}{2}$ to 1 metre in height, provided with a tightly-fitting lid, and covered with thick felt. The apparatus is filled about one-fourth with distilled water, and heated by a gas or other flame sufficiently powerful to make the water boil rapidly, and this temperature is to be maintained during the entire period required for sterilisation. A thermometer in the lid indicates the temperature of the steam. Into the interior of the boiler, but above the level of the water, fits a tin vessel (Fig. 9) with a perforated bottom. Into this case the article to be sterilised is placed, and the cover fixed. The case can then be lowered into the boiler by means of the wire handle.

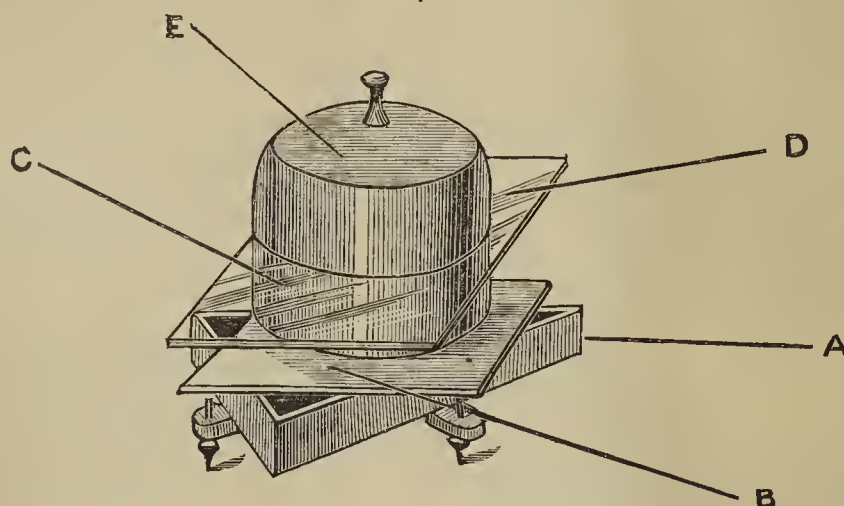
ON THE ABSORPTION-SPECTRA OF CERTAIN COLOURING MATTERS.

By MM. GIRARD and PABST.

THE study of absorption spectra may render great services in analytical chemistry; whilst it does not alter the nature of the object under examination, and gives decisive results with minute quantities of material, it can guide the chemist in towards the track to be pursued and confirm the results of his experiments.

Vogel's work ("Die Praktische Spectral Analyse irdischer Stoffe") contains the description of most of the colouring matters known at the time of its appearance.

FIG. 7.



Thin cover glasses, and plain and cupped slides, together with glass rods six inches long, with a platinum wire about

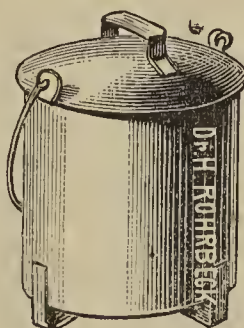
FIG. 8.



three inches in length fused in at one end, must also be provided. The wires should be of different thicknesses.

(To be continued.)

FIG. 9.



The present authors have studied some of the colours which have appeared in commerce since that date, and have added to their memoir a diagram, for which we must refer to the original.

Magenta gives an exceedingly intense and well-defined absorption-band, visible in very dilute liquids. Acid magenta or its sulpho-conjugated derivative gives the same band a little displaced towards the red, and in addition another band at the beginning of the blue. These two bands disappear, along with the red colour, under the influence of an alkali. Methyl-green (trimethyl-rosaniline dichloro-methylate) gives a spectrum closely resembling those of malachite green (the tetra-methylated derivative of diamido-triphenyl-methane) and of brilliant green, which differs from malachite green by the substitution of four ethyl radicles for methyl: it is a direct homologue, but the spectra of these two homologues resemble each other strikingly.

They have also observed remarkable analogies between the absorption-spectra of aureosine with chlorine and of eosine, as well as of their methylated derivatives.

They have ascertained that the analogy of the absorption-spectra continues in colouring matters of analogous origin, having examined an entire series of the colouring matters derived from β -naphthol by the combination of the diazo-radicles.

The azo-compounds examined are:—

- Orange 2: diazo-benzol and sulpho- β -naphthol.
- Ponceau RR: diazo-ethyl-xylene and β -disulpho- β -naphthol.
- Ponceau B: a homologue of the former.
- Biebrich red: diazo-azobenzol and sulpho- β -naphthol.
- Bordeaux B and R: diazo-naphthaline and sulpho- β -naphthol.
- Congo-red: tetrazo-diphenyl and sulpho- β -naphthol.

This last-mentioned product gives a garnet-red solution, which with acids turns to a violet. In this case the absorption is slightly intensified about the line F.

They have applied the study of these absorption-spectra

Zymase of Jequirity.—J. Béchamp and A. Dujardin.
—The authors announce their intention of demonstrating that the microzymas of the jequirity possess exactly the same properties as jequirity-zymase.—*Comptes Rendus*.

to the detection of artificial colouring matters in so-called fruit-syrups. The colouring matter of natural syrups is red, which is turned green by alkalies, and is not removed by amylic alcohol either in an acid or an alkaline solution.

Magenta and acid magenta are detected by agitating the syrup with amylic alcohol, acidulated with a little weak hydrochloric or sulphuric acid, and examining the decanted alcohol with the spectroscope. If magenta or acid magenta is present there is a broad band in the green; with orchil there is a general darkening of the spectrum from the violet to the yellow, the shade being intensified about the line D. Ammoniacal cochineal shows two bands, one between D and E, but nearer the latter, and one between E and F.

The amylic alcohol is then shaken up with ammonia-water, which takes a violet colour in case of orchil and cochineal; observation with the spectroscope decides the nature of the colouring-matter. With magenta the amylic alcohol takes a red colour on the addition of acetic acid. Acid magenta is found in the ammoniacal solution, which is acidulated and examined with the spectroscope. The azo-derivatives are easily found by their solubility in amylic alcohol in an ammoniacal liquid.

In wines acid magenta is easily detected by saturating with excess of potash, precipitating with mercury acetate, and acidulating the filtrate. If this liquid becomes red and shows the characteristic absorption-band, and is completely decolourised on the addition of an alkali, we may infer the presence of acid magenta.

In the majority of cases acid magenta is directly detected in coloured liquids by diluting them with water down to a faint rose shade: the absorption due to the other colours disappears, and the band of acid magenta is still distinct enough to be identified.

Greenish Bordeaux (a mixture of acid magenta with other colouring matters, generally methylen-blue and diphenylamine-orange) gives two absorption-bands, and is identified like magenta.

The attempts made to photograph the absorption-bands have not as yet given satisfactory results.—*Comptes Rendus*.

ON THE
SEPARATION OF TITANIUM AND ALUMINUM,
WITH A
NOTE ON THE SEPARATION OF TITANIUM
AND IRON.*

By F. A. GOOCH.

IN attempting to separate titanium and aluminum it is usual to resort to that method which depends upon the action of the slightly acid solution of the sulphates when submitted to prolonged boiling. The faultiness of this method, however, becomes apparent when solutions of aluminum and titanium are compared as to behaviour under the conditions. To secure the complete precipitation of titanium the excess of sulphuric acid must be kept small, while to prevent the deposition of alumina the acid must be more than enough to dissolve the same amount freshly precipitated as hydrate, in the cold. Thus, upon boiling solutions containing the equivalent of 0.06 grm. of titanic oxide, 2.5 grms. of free sulphuric acid, beside alkaline sulphates, in 800 c.m.³ of water, it was found that at the end of an hour 0.003 grm. of titanic oxide in one case, and 0.006 grm. in another experiment, had escaped precipitation; but that, when the solution of titanium had first been precipitated by ammonia, and then made just acid by sulphuric acid, every trace of dissolved titanium was thrown out on boiling. The experiment, on the other hand, of boiling a grm. of alum—roughly speaking 0.1 grm.

of alumina—in 800 c.m.³ of water shows almost immediately the deposition of some alumina, and the same thing happens when the alumina is first precipitated by ammonia and then dissolved by just enough sulphuric acid to effect the solution. The difficulty of so adjusting the acidity of the solution that no alumina shall be deposited and no titanium held up, is obvious. Test-paper is of no aid in the case, since the reaction of alum itself and aluminic sulphate is acid. Under the circumstances it is hardly surprising that Knop* should revert from the troublesome, and only under remote conditions more exact, method of separation by boiling to the convenient but indubitably inaccurate process of parting by the use of sodic hydrate. Knop employs both the dry and the wet method—the fusion of the oxides in sodic hydrate, and the treatment of the salts in solution with sodic hydrate in excess; but both had long before been generally discarded, and the single experiment of acidulating the alkaline filtrate from a precipitate obtained by the treatment of a pure titanium salt according to either mode, and then making alkaline with ammonia, is enough to prove their worthlessness.

In an endeavour to secure a better means of separating titanium from aluminum I have followed two lines of experimentation;—the one based upon the observation that, under properly controlled conditions, titanium is completely precipitated and alumina held in solution when an alkaline orthophosphate, strongly acidified with formic acid, is added to the solution of salts of these elements; the other, upon the solubility of alumina and the insolubility of titanic hydrate in sufficiently strong boiling solutions of acetic acid. Two preparations of titanium were used as test material in the course of the work:—The solution of the fusion in sodic bisulphate of the hydrate precipitated by ammonia from the fluoride of titanium and potassium itself made from rutile and carefully purified by re-crystallisation; and the solution obtained by treating the carefully-prepared double fluoride with sulphuric acid, evaporating to dryness, re-dissolving in sulphuric acid, and diluting with water. The second mode of preparation is the better, because the amount of alkaline sulphate present in the test solution is much smaller. At first the strength of the solution was fixed by precipitating weighed amounts by ammonia, carefully washing, igniting, and weighing the precipitate; but in the course of the work it became plain that the precipitation by means of ammoniac acetate, or by ammonia with the subsequent addition of acetic acid in distinct excess, yielded more precise results. On this account, therefore, the determinations of the standard of the solutions employed in the later work were made by the acetic acid process, and the determinations by ammonia were corrected to correspond. In some of the experiments bearing upon this point, the results of which are given in the figures below, precipitations by ammonia were made in the cold, and the liquid then heated to boiling; in those in which acetic acid was used just in excess this reagent succeeded the ammonia at once, and the boiling followed; when precipitation was effected in presence of large amounts of acetic or formic acid, the acid was added in the amount intended, sodic acetate in quantity more than that necessary to decompose the sulphates present was introduced, and the clear solution heated to boiling, and kept boiling for a minute or two. The acetic acid employed was the C.P. article of commerce, and contained 35 per cent of absolute acid. The amounts of it used—20, 30, 40, and 50 per cent by volume—correspond to 7, 10.5, 14, and 17.5 per cent of absolute acid. The formic acid contained 27 per cent of pure acid, and when it is said that there was in solution 5.4 per cent of it, the absolute acid is meant; but it was the weaker acid, to the amount of 20 per cent of the entire volume, which was actually used. The experiments were made in sets, and so appear in the record, in consequence of changes (due to

* From the *Proceedings of the American Academy of Arts and Sciences*, New Series, vol. xii.

* *Jahrb. f. Min.*, 1876, p. 756; *Zeit. f. Kryst. u. Min.*, i., 58.

slight depositions from time to time) in the strength of the test solution, which necessitated re-determinations of standard.

	Weight of solution. Grms.	TiO ₂ found. Grm.	TiO ₂ in 50 grms. Grm.	Mode of precipitation.
{ (1)	52.7370	0.3177	0.3012	} By ammonia.
(2)	52.7610	0.3180	0.3012	
{ (3)	52.7620	0.3076	0.2912	} By ammonia and ex-
(4)	41.8010	0.2436	0.2914	
				cess of acetic acid.
{ (5)	52.9420	0.3381	0.3193	} By ammonia.
(6)	53.0200	0.3384	0.3191	
{ (7)	10.6300	0.0667	0.3137	} By acetic acid 7%
(8)	10.6960	0.0671	0.3137	
				by volume.
{ (9)	21.1030	0.1285	0.3044	} By ammonia.
(10)	21.1480	0.1290	0.3049	
{ (11)	21.0810	0.1248	0.2960	} By acetic acid 14%
(12)	21.1670	0.1259	0.2974	
				by volume.
{ (13)	21.0620	0.1270	0.3015	} By ammonia.
(14)	21.2310	0.1279	0.3012	
{ (15)	10.4370	0.0617	0.2956	} By acetic acid 10.5%
(16)	10.6590	0.0629	0.2950	
				by volume.
{ (17)	10.4870	0.0618	0.2946	} By acetic acid 14%
(18)	10.8820	0.0637	0.2940	
				by volume.
{ (19)	10.4700	0.0615	0.2938	} By formic acid 5.4%
(20)	10.7410	0.0627	0.2919	
				by volume.
{ (21)	52.3960	0.3396	0.3230	} By ammonia.
(22)	52.4140	0.3378	0.3222	
(23)	52.6350	0.3340	0.3262	
{ (24)	52.5600	0.3372	0.3208	} By acetic acid in
(25)	52.4830	0.33661	0.3207	
		0.336311	0.3204	
				distinct excess.
{ (26)	52.3700	0.3348	0.3196	} By acetic acid 17.5%
(27)	52.6420	0.3374	0.3205	
				by volume.

It will be noticed in the examination of these figures that parallel determinations usually agree very closely. The amounts of titanic oxide indicated by those experiments in which the precipitation was made by ammonia are much in excess of those in which acetic acid was added subsequently. Thus, the difference between (1), (2), and (3), (4), amounts to more than three per cent of the total amount of the former; that between (5), (6), and (7), (8), to a little less than two per cent; that between (9), (10), and (11), (12), to about two and a half per cent; and a correction of more than two per cent must be applied to (13), (14), to bring them to correspondence with (15), (16), (17), (18). The difference between (21), (22), (23), and (24), (25), (26), (27) is about one per cent, and the smallness of this figure in comparison with the differences previously noted is apparently explicable by the fact that the solution of titanium employed in the last determinations was prepared by the second of the methods mentioned above, and carries a smaller amount of alkaline sulphate. The tendency of titanic hydrate to include the sulphates of the alkalis is not strange, in view of the well-known conduct of aluminic hydrate under similar circumstances, but the amount thus held is rather surprising. The experiments in which different proportions of free acid were introduced go to show, very strikingly, that, if acetic acid exerts any solvent action whatever upon the precipitate thrown down by boiling the acetate, that action is very slight. Thus, between the mean of (24), (25), and that of (26), (27)—

the one set precipitated by ammonia and treated before boiling with just a distinct excess of acetic acid, the other pair thrown out of a large volume, 700 c.m.³, one half of which was acid of 35 per cent strength, by boiling—we find a difference of but 0.0007 gm., and between the mean of (15), (16), and that of (17), (18), the difference (magnified five times by reference to 50 gm. portions) is 0.0010 gm. In (25), too, we have an experiment in which the weighed precipitate was fused in sodic carbonate, dissolved, and again precipitated as before and weighed, the two weights differing by 0.0003 gm. Moreover, the filtrates from the precipitates thrown out in presence of an excess of acetic acid, when neutralised with ammonia, failed invariably to show the smallest precipitate, and in direct experiments upon the sensitiveness of the reaction it was found that, on the addition of 0.0005 gm. of titanic oxide in solution to 100 c.m.³ of 35 per cent acetic acid, carrying a little sodic acetate, a distinct precipitate appeared almost immediately on boiling. It is plain, therefore, that so far as concerns the purpose in hand, the insolubility of the titanium precipitate in acetic acid may be taken as absolute. The small apparent losses to be observed in some of the determinations in which a large excess of acetic or formic acid was employed, are probably explicable by the tendency of the precipitate to change its consistency as the amount of free acid increases, and, in very acid solutions, to show an inclination to adhere in small amounts, but quite persistently, to the vessel in which precipitation takes place. The adherent precipitate may be dislodged with ease by putting a little hydrochloric acid into the beaker to which the precipitate adheres, covering and heating gently so that the acid volatilised may condense upon the walls of the beaker and again run down. By then rubbing the walls of the beaker a little and adding ammonia in excess, the trace of residual titanium is completely recovered. This method of recovery was applied in (26) and (27).

In preliminary experiments upon the first of the methods which seemed to promise a separation of titanium and aluminum, it was found that the precipitation of titanium by an alkaline orthophosphate is complete in the presence of a large amount of acetic or formic acid, and that, in the cold, and under conditions otherwise properly controlled, aluminic phosphate fails to appear. To hold up the alumina by means of acetic acid requires some care in the adjustment of the acid and phosphate, and to re-dissolve the precipitate once formed is a matter of considerable difficulty. Thus, to clear the solution of a precipitate produced by 1.5 grms. of the phosphate of soda and ammonia upon 0.1 gm. of alumina, it was necessary to dilute the liquid to a volume of 250 c.m.³, and add acetic acid until there was in the solution at least five per cent of absolute acid; and the addition of 1.5 gm. more of the precipitant again precipitated aluminic phosphate. Formic acid, however, is more active, and the balance between it and the precipitant not so delicate. When the proportion of three parts by weight of absolute formic acid to two parts of microcosmic salt is kept, the aluminic phosphate does not fall; and if, because of a deficiency of acid, precipitation does take place, the liquid immediately clears so soon as the proportion of acid and precipitant is restored. Formic acid, therefore, was used in the experiments about to be described. The test solution of titanium was that employed in the previous experiments (1) to (20), but, inasmuch as the error of the process had not yet been remarked, the standards were determined by precipitating by ammonia, and are therefore to be corrected. The application of a correction of 2½ per cent to the apparent weights of titanic oxide found by the ammonia process—the mean correction for (1), (2), (5), (6), (9), (10), (13), (14),—cannot lead far away from the truth, since the difference between the maximum and minimum corrections observed amounts for the quantity of material employed in these experiments to but 0.0002 gm. Determinations of standard, original and corrected, are given in (28), (29), (30), and (31).

	Weight of Solution. Grms.	TiO ₂ found. Grm.	Corrected TiO ₂ in 50 grms. Grm.	Corrected TiO ₂ in 50 c.m. ³ Grm.
(28)	52.7660	0.3867	0.3572	0.3771
(29)	52.8410	0.3869	0.3569	
(30)	52.5380	0.3810	0.3627	
(31)	52.6920	0.3822	0.3627	

A portion of the solution, the standard of which is set by (28) and (29), was diluted to ten times its volume, and 50 c.m.³ of the diluted solution were used in each of the experiments immediately following. These were made to determine whether the precipitate was definite in composition, and might be weighed as such. Precipitation was effected by a solution of microcosmic salt acidified with formic acid. The precipitates of (32) and (33) were collected on paper, that of (34) on asbestos, and all were ignited and weighed directly.

	Amount taken.	TiO ₂ and P ₂ O ₅ found. Grm.	TiO ₂ by Standard. Grm.	P ₂ O ₅ by Difference. Grm.
(32)	50 c.m. ³	0.0731	0.0377	0.0354
(33)	"	0.0640	0.0377	0.0263
(34)	"	0.0753	0.0377	0.0376

The phosphate obtained by Merz* by precipitating in presence of hydrochloric acid containing two molecules of TiO₂ to one of P₂O₅, requires 0.3326 gm. of P₂O₅ to 0.0377 gm. of TiO₂. It will be noticed that in two determinations the P₂O₅ is in a considerable excess of the amount demanded by this proportion, and in one in deficiency. The idea of weighing the phosphoric anhydride and titanate together was therefore abandoned.

In experiments (35), (36), (37) the titanium was present alone; in (38), (39), 2 grms. of alum were added to the solution before precipitating by means of the mixture of microcosmic salt and formic acid, 5 grms. of the former being employed to 8 grms. of the latter. The precipitates of all, excepting (35), were carefully washed, ignited, fused with sodic carbonate, and the product of fusion was dissolved in water, the insoluble titanate separated from the soluble phosphate by filtration and washing, ignited, again fused with a little sodic carbonate, the result of fusion dissolved in strong sulphuric acid, diluted with water, and precipitated by ammonia with the subsequent addition of acetic acid, and boiling. Experiment (35) was conducted in like manner, excepting that the sodic titanate was dissolved off the filter by means of a mixture of hydrochloric and oxalic acids, the latter destroyed by potassic permanganate (since there is danger that in presence of ammoniac oxalate the titanium may not be completely separated by ammonia), ammonia added in excess, then acetic acid to

strongly acid reaction, and the liquid boiled. This mode of treating the acid titanate is not desirable, since the titanate hydrate, if precipitated but once subsequently, retains a trace of manganese. To fuse the titanate with sodic carbonate, and then treat the melt with strong sulphuric acid, is probably the best way of getting the titanium into solution again. The test solution of (28) and (29) was employed in experiment (35), and that of (30) and (31) in the rest.

From experiments (36) and (37), together with (35), which, as has been remarked, would naturally give figures slightly too high, it appears that the method indicates with accuracy the amount of titanium present. Experiments (38) and (39) indicate that the separation from alumina is not unreasonably inexact.

	Weight of Solution. Grms.	TiO ₂ found. Grm.	TiO ₂ by Standard. Grm.	Error. Grm.
(35)	5.2220	0.0383	0.0373	0.0010 +
(36)	5.2300	0.0371	0.0370	0.0001 +
(37)	5.3840	0.0380	0.0381	0.0001 -
(38)	5.2920	0.0367	0.0374	0.0007 -
(39)	5.2540	0.0383	0.0372	0.0011 +

The tediousness of filtration, which is a consequence of the nature of the phosphate precipitate, is the great objection to the method, and on account of it the testing was pushed no further, attention being turned instead to the second line of experimentation.

(To be continued).

ANALYSES OF BITUMINOUS COALS FROM ALABAMA, TENNESSEE, AND KENTUCKY, UNITED STATES OF AMERICA.

By N. T. LUPTON, Professor of Chemistry, Vanderbilt Univ.

THE following tabular statement presents the results of nineteen analyses of specimens of coal from the various localities mentioned. Care was taken in preparing the specimens for analysis to select a considerable number of pieces, representing as near as possible an average of the coals as furnished for use in the city of Nashville. These were broken up, sampled, and pulverised in the usual manner.

The usual methods were used in determining the various proximate constituents, and the analyses were conducted under conditions as nearly uniform as possible.

In estimating moisture it was found that half-an-hour's

No.	Name and locality.	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Total.	Sulphur.	Sp. gr.
1.	Cumberland, Md.	0.867	18.527	74.206	6.400	100	0.780	1.322
2.	Pittsburg, Penn.	1.345	37.182	56.354	5.119	100	1.258	1.281
3.	Pratt, Alabama	1.020	31.853	63.821	3.306	100	0.701	1.252
4.	Warrior, Alabama	1.190	32.341	65.107	1.362	100	0.416	1.271
5.	Black Creek, ,,	1.102	33.445	63.622	1.831	100	0.556	1.271
6.	Watt, ,,	1.120	30.682	61.846	6.352	100	0.807	1.346
7.	Cahaba, ,,	1.682	34.131	60.160	4.027	100	0.564	1.331
8.	Helena, ,,	1.346	34.185	55.767	8.702	100	0.626	1.360
9.	Blockton, ,,	1.759	34.139	56.682	7.420	100	0.758	1.317
10.	Henry Ellen, ,,	1.406	34.475	58.156	5.963	100	0.308	1.313
11.	Sewanee, Tenn.	1.783	29.527	60.858	7.832	100	1.081	1.325
12.	Daisy, ,,	0.675	29.426	60.694	9.205	100	2.252	1.334
13.	Jellico, Kentucky	1.340	37.600	59.050	2.010	100	0.802	1.263
14.	Altamont, ,,	2.495	36.657	58.770	2.078	100	1.084	1.248
15.	Mud River, ,,	2.931	35.681	57.622	3.766	100	0.794	1.241
16.	St. Bernard, ,,	2.945	35.592	52.096	5.367	100	3.337	1.245
17.	Memphis, ,,	2.485	38.652	53.525	5.338	100	2.389	1.241
18.	Diamond, ,,	2.985	36.092	52.760	10.163	100	3.666	1.267
19.	Clifton, ,,	2.614	36.486	51.875	9.035	100	2.307	1.289

* *Journal für Praktische Chemie*, xcix., 157.

exposure in an air-bath to a temperature of 105° to 110° C. was sufficient to give satisfactory results. Careful deflagration with an intimate mixture of six parts by weight each of chemically pure sodium carbonate and nitrate was used in the determination of sulphur.

The specific gravity was determined by means of Jolly's spring balance, three determinations being made in each case, and the average of results, fairly concordant in every instance, taken.

Nos. 3, 4, 5, and 6 are from what is known as the Warrior Coal-field of Alabama.

Nos. 7, 8, 9, and 10 are from the Cahaba Coal-field of Alabama.

Nos. 11 and 12 from the Cumberland Mountains of Tennessee.

Nos. 13 and 14 are from South-eastern Kentucky.

Nos. 15, 16, 17, 18, and 19 are from South-western Kentucky.

Vanderbilt University, Nashville, Tenn.,
June, 1885.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. c., No. 26, June 29, 1885.

Researches on Isomerism in the Aromatic Series. Neutralisation Heat of the Oxybenzoic Acids.—MM. Berthelot and Werner.—The study of the isomeric poly-atomic phenols has led the authors to show their constitutional difference by the determination of their neutralisation-heats. The phenols obtained by two substitutions, effected in one and the same acetylenic molecule, that is to say, derivatives belonging to the orthobenzenic series, are very clearly distinguished from the phenols obtained by two substitutions effected in two different acetylenic molecules; that is, from the meta-benzenic and para-benzenic derivatives. These two orders of phenols repeat twice the phenolic function in presence of bases, whilst the orthobenzenic phenols manifest it once less frequently. The authors have sought if this relation can be generalised, and they have found that the results obtained with the three oxybenzoic acids are entirely conformable.

Nacreous Crystals of Sulphur.—D. Gernez.—The author maintains his priority in the observation of nacreous crystals in opposition to the claim put forward by M. Maquenne on behalf of M. Sabatier.

Properties of Hydrogen Persulphide.—P. Sabatier.—The author refers to his former statement that hydrogen persulphide is a mixture of a disulphide with a large excess of dissolved sulphur, and adds that it contains, also, a notable quantity of sulphuretted hydrogen, which can easily be eliminated by pressure. He denies that he claimed priority in the observation of the nacreous sulphur obtained with ether, which is due to Thénard. He maintains that the nacreous crystals are transformed into octahedra, becoming at the same time opaque and yellow. If introduced into a cold supersaturated solution of sulphur in benzol, they give a nacreous deposit, strictly identical, whilst the octahedral sulphur yields merely octahedra.

Action of Anhydrous Ammoniacal Ammonium Nitrate upon Certain Metals.—G. Arth.—The author has observed that, on causing this liquid to act upon different metals in an apparatus excluding all access of air, the ammonium nitrate is reduced by some or them, even at the ordinary temperature, and without the aid of

any solvent. Zinc and iron were thus acted upon, whilst tin and copper remain quite inert. Zinc disappears completely, in course of time, and the mixture is solidified. On opening the apparatus there is an escape of ammoniacal gas. The soluble matter was freed from excess of ammonia and treated with water. The solution contains a notable quantity of nitrites and zinc oxide in abundance. It becomes turbid on adding excess of water, and deposits zinc oxide.

Reduction of Hexatomic Alcohols.—J. A. Le Bel and M. Wassermann.—This memoir does not admit of useful abstraction.

New Method of the Production of Pyrocatechin.—J. Meunier.—The author, by heating benzol hexachloride in sealed tubes with water, obtains a diphenol having all the properties and reactions of pyrocatechin.

Action of Chlorine and Iodine upon Pilocarpine.—M. Chastaing.—The action of chlorine is similar to that of bromine. In the absence of water there is produced bichloro-pilocarpine bichloride hydrochlorate. In presence of a little moisture there is formed a base poorer in carbon. Iodine, under similar circumstances, forms merely a mono-iodo-compound.

Determination of Phosphoric Acid in the Phosphates supplied in Agriculture.—E. Aubin.—In the analysis of phosphates the author proceeds as follows:—1 grm. of the pulverised sample is placed in a 200 c.c. flask, along with 10 c.c. of hydrochloric acid, and kept at a boil for about 10 minutes. There are then added 10 c.c. of a liquid formed by dissolving in the cold crystallised sodium acetate to saturation in acetic acid at 8° B. The volume is then made up to 40 or 50 c.c. without removing the fire. When the liquid is boiling strongly, 2 to 3 grms. of ammonium oxalate are added, and after a few minutes the heat is withdrawn. The liquid clears rapidly, and is decanted upon a filter, and the insoluble residue is washed repeatedly. When cold, the liquid is rendered ammoniacal by adding ammonia, and 20 c.c. of ammonium citrate are added to keep the iron and aluminium in solution. To precipitate the phosphoric acid it is merely necessary to add magnesia mixture in excess, made by dissolving 290 grms. crystalline magnesium chloride and 150 grms. ammonium hydrochlorate in water enough to make up 1 litre. The final volume should be 250 c.c., and should contain 40 to 50 c.c. of ammonia at 22° ; these precautions are necessary to precipitate all the phosphoric acid without carrying down free magnesia. The ammonium-magnesium phosphate is collected on a filter, washed with ammoniacal water saturated with the foregoing salt, dried, incinerated, and weighed. The weight obtained, multiplied by 63.963, gives the percentage of phosphoric acid in the substance analysed. The presence of calcium fluoride does not interfere.

Vol. ci., No. 1, July 6, 1885.

Carbonates in Living Plants.—MM. Berthelot and André.—In this extensive memoir the authors find that plants contain certain principles capable of being split up under the influence of natural ferments, or by prolonged boiling, producing alkaline carbonates, or rather bicarbonates. This result agrees with what we know of the ethereal compounds contained in organic liquids, and their being split up by hydration.

Spectrum of Ammonia on Reversing the Induced Current.—Lecoq de Boisbaudran.—If we cause the induction-spark to strike upon an aqueous solution of ammonia, rendering the liquid positive, there is formed in the interpolar space a yellow, globular, or dome-shaped sheet, contracted below, though increasing in lustre, and terminating in a point very near the surface of the liquid. Around this point, and applied to the external surface of the liquid there is developed a small greenish disc, very slender, with distinct outlines. The light of this disc gives a spectrum with a fine green band. The yellow sheet yields also a spectrum of a very different kind from that

of the green disc, which seems to be identical with one of those described by Messrs. Dibbitts and A. Mitscherlich, and obtained by means of a flame saturated with ammonia. This spectrum is composed of a great number of nebulous rays, some of which, very close to each other, melt into small nebulous bands.

Reductive Properties of Pyrogallol; Action upon the Salts of Iron and Copper.—P. Cazeneuve and G. Linossier.—A boiled solution of ferrous sulphate and a solution of pyrogallol in boiled water are introduced into a tube filled with mercury, air being excluded. No colour is produced, but the introduction of a little oxygen determines the appearance of a blue colour. The oxygen absorbed in this case combines with the pyrogallol, and the blue colouring-matter is the product of the oxidised pyrogallol upon a ferrous salt.

Acetic Solution of the Alkaline Hyposulphites.—E. Mathieu-Plessy.—Acetic acid exerts only a slight decomposing action upon sodium and potassium hyposulphites. A solution of sodium hyposulphite (saturated cold) does not deposit more than $1\frac{1}{2}$ per cent of sulphur if mixed with half its volume of acetic acid at 8° . This solution gives finer crystals than those obtained with an aqueous solution, equivalent as far as its proportion of hyposulphite is concerned. This acid solution of hyposulphite in presence of magnesium becomes heated with a tumultuous escape of hydrogen and hydrogen sulphide. The alkaline hyposulphites (thiosulphates), even when dissolved in monohydrated acetic acid, offer a stability which reminds us of the sulphates. These facts seem favourable to the view that thiosulphuric acid is a substituted sulphuric acid.

New Method of Determining Cadmium.—Ad. Carnot and P. M. Proromant.—See p. 42.

New Process for the Detection and the Rapid Determination of Small Quantities of Nitric Acid in Air, Water, and Soils.—Al. Grandval and H. Lajoux.—See p. 42.

Formation of Nitre Soils in Tropical Countries.—A. Muntz and V. Marcano.—The authors' observations lead them to ascribe to these deposits a purely animal origin. Their locality, the constant presence of large quantities of phosphates, and the phenomena observed in the deposits in course of formation, leave no room for the hypothesis of electrical action.

Composition and Fermentation of Inverted Sugar.—E. Bourquelot.—A reply to a paper by M. Maumené in the *Comptes Rendus* for June 15th last. The author points out that he expressly rejects the expression "effective fermentation."

Bulletin de la Société Chimique de Paris.
Vol. xliii., No. 12, June 20, 1885.

The Derivatives of Selenurea.—A. Verneuil.—Already noticed.

Formation of Normal Propyl-benzene.—MM. Wispek and Zuber.—The authors put forward a claim of priority against M. Silva, and maintain, further, that his "isopropyl-benzene" is normal propyl-benzene.

The Formation of Normal Propyl-benzene: Reply to the foregoing Reclamation.—R. D. Silva.—The author maintains that in the same reaction either normal propyl-benzene, or isopropyl-benzene, or both of these hydrocarbons, may be produced according to the conditions of the experiment.

Composition and Combustion-Heat of a Coal from the Basin of the Ruhr.—M. Scheurer-Kestner.—Already noticed.

On a Monochloric Methyl-benzoyl.—H. Gautier.—In the action of acetyl chloride upon phenyl chloride, in presence of aluminium chloride, the product is almost exclusively parachloro-methyl-benzoyl.

Observations relative to the External Constitution of the Albumenoids, and their Transformations.—A. Gautier.—A critique on M. Grimaux's definition of the albumenoids as nitrogenous colloids, which, on hydration, are split up into carbonic acid ammonia and amidic acids.

MISCELLANEOUS.

The British Association.—We learn from Dr. Armstrong that arrangements have been made for two discussions in the Chemical Section over which he will preside at the meeting at Aberdeen of the British Association. The one will be on the Determination of the Molecular Weights of Liquid and Solid Bodies; the other on Electrolysis. It is proposed to have a series of critical papers read which shall embody, as far as possible and desirable on such an occasion, our knowledge of these subjects, and also indicate the directions in which investigation is specially required and may be most usefully carried on. These subjects have been chosen as being of general interest and of special importance to the chemist, and in the hope of inducing chemists and physicists to co-operate in attacking the many problems which await solution. Capt. Abney will open the first discussion with a paper on the Spectroscopic Method; Profs. Guthrie, Reinold, and Tilden, Mr. S. U. Pickering, Dr. Russell, and Dr. Armstrong will also contribute papers. Prof. Lodge will open the discussion on Electrolysis, and Prof. Schuster, Capt. Abney, Dr. Wright, and Mr. Shelford Bidwell have already consented to contribute papers on portions of this subject. Dr. Armstrong will be glad to hear from any other gentlemen who have special views on either of the subjects.

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THE CHEMICAL NEWS.

VOL. LII. No. 1341.

THE MECHANICAL PRODUCTION OF COLD AND THE EFFECTS OF COLD UPON MICROPHYTES.*

By J. J. COLEMAN, F.C.S., F.I.C., and
Professor J. G. MCKENDRICK, M.D., LL.D., F.R.S.

THIS discourse was delivered by Mr. J. J. Coleman, and embraced two parts, viz., 1st, a description of his own researches and their application in the construction of cold-producing machines; and 2nd, a description of a joint research undertaken by Prof. McKendrick and himself upon the effects of very low temperatures upon microphytes.

Mr. Coleman pointed out that in the first place the title of the discourse might be objected to, inasmuch as it was scarcely correct to speak of the "production of cold." As, however, long usage had made the phrase conventional, it would be used in the sense of meaning production of a state of coldness.

A close examination of all known methods of producing cold by artificial means involved the employment of some volatile liquid or compressed vapour capable of spontaneously expanding. Thus, commencing with water, its spontaneous evaporation produced the state of coldness of the domestic water-cooler.

The evaporation of ether, as in the spray used by surgeons; also the evaporation of liquid sulphurous acid, which boiled at $-10^{\circ}\text{C}.$; of liquid carbonic acid, which boiled at $-78^{\circ}\text{C}.$; of liquid nitrous oxide, which boiled at $-86^{\circ}\text{C}.$; of liquid ethylene, which boiled at $-102^{\circ}\text{C}.$; or of liquid air, which boiled at $-191^{\circ}\text{C}.$, were all perfectly analogous to the spontaneous expansion of compressed air, when released from pressure by opening the cock of a vessel containing it.

The nearer the compressed vapour is to the state of a perfect gas, or of a hypothetical perfect gas, the more exactly is the heat absorbed by expansion balanced by the heat generated by the friction of the molecules before coming to rest. This followed from the joint researches of Sir William Thomson and Dr. Joule conducted thirty years ago.† These eminent men, in a classical series of experiments, the description of which occupies 122 pages of Sir William Thomson's researches, and involved upwards of 1000 observations collected in 50 tables, demonstrated among other things that air having a pressure of 100 lbs. per square inch, when passed through a porous plug so as to reduce its pressure to that of the atmosphere, only becomes cooled to the extent of $1.6^{\circ}\text{C}.$, hydrogen gas similarly expanded being heated $0.116^{\circ}\text{C}.$

Free expansion of atmospheric air under pressure through a small orifice of any kind was similar in its results, which Mr. Coleman demonstrated by expanding a cubic foot of air of several atmospheres pressure into a glass reservoir or chamber containing a delicate air thermometer, which was not in the least affected, although the result was thrown upon the screen magnified and illumined by a beam of electric light.

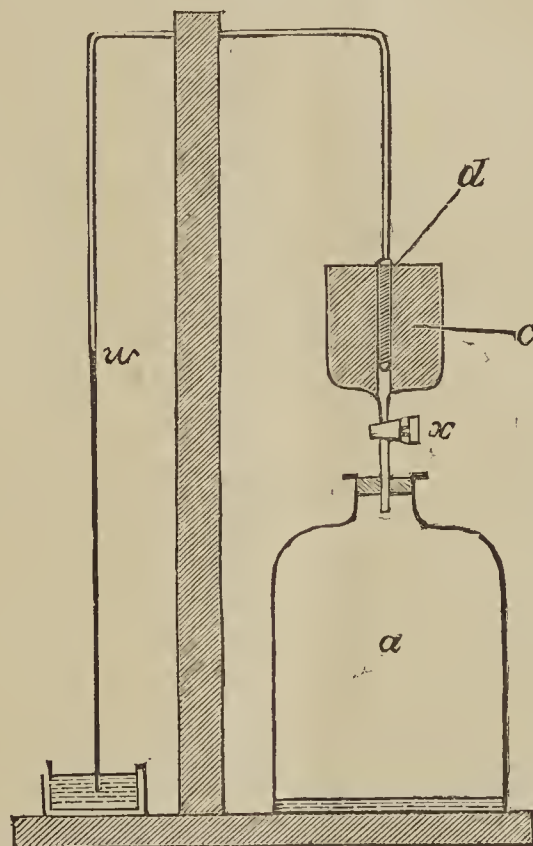
It was otherwise, however, when the experiment was made as originally conducted by Gay-Lussac and Dr. Joule, in which case the vessel containing the air being expanded became cold, and the vessel into which the air flowed became hot, the one phenomenon neutralising the other.

Mr. Coleman showed by an arrangement of his air thermometer, the index of which was projected upon the screen, that the vapour which exists in an ordinary bottle containing a little liquid ether has sufficient tension to cause friction and production of heat in escaping through a narrow orifice.

In this case the heat abstracted from the evaporating liquid was compensated by the latent heat absorbed in conversion of the ether liquid into ether gas + the heat caused by the *vis-viva* of the escaping molecules coming into contact with the walls of the orifice and afterwards with the external atmosphere.

The apparatus used was called a "Tripatmoscope," and was constructed as follows:—

a is a bottle of say $\frac{1}{2}$ th of a cubic foot capacity, containing a small quantity of liquid ether, and into the neck of which was fitted by an indiarubber cork a glass funnel. *c* is a plug of boxwood cemented into the funnel bowl, and having an annular aperture barely sufficient to admit the



thin copper cylindrical bulb, *d*, of an air thermometer, say $\frac{1}{2}$ -inch diameter and 6 inches long, and packed tight into the boxwood by making the bulb a little sticky with mastic varnish and winding round it fine cotton thread. On opening the cock, *x*, at intervals of a few minutes, a marked fall of the water index, *w*, occurred, which was magnified and illumined by a beam of electric light—indicating nearly $1^{\circ}\text{F}.$ produced by friction of escaping vapour.‡

The statement that is met with in some text-books, that no cold can be produced by expanding air without *mechanical work* being performed, is not strictly correct, as one fraction of a given volume of air can be cooled by blowing the other fraction into the atmosphere; but all such methods of producing cold are, however, from an engineering point of view, wasteful, for to make an economical machine energy must be abstracted from the expanding medium (generally in the form of mechanical power, but not necessarily, as for instance in the ammonia absorption machine) before the *whole* volume of the gaseous medium can be reduced in temperature; and not only is this necessary, but in order to enable the medium,

* A Lecture delivered before the Royal Institution of Great Britain, May 29, 1885.

† "On the Thermal Effects of Fluids in Motion." See collected papers of Sir W. Thomson, vol. i., Cambridge University Press, 1882.

‡ This instrument works best in an atmosphere of about $70^{\circ}\text{F}.$, but with a slight occasional agitation of the liquid ether gives good results at 60° .

when it has arrived at atmospheric temperature, to be employed for a fresh cycle of operations, energy must be introduced and then rejected.

In the case of atmospheric air the energy used in compression appears as heat every cycle which has to be rejected, and this is accomplished either by washing the air with injected water or by passing it through tubes surrounded by water.

Some idea of the heat required to be removed each cycle is afforded by the fact that compression of air to the extent of 65·86 lbs. per square inch above the atmosphere increases its temperature by 332° F.

It is now about five years since machinery of this kind came into extensive use, and for a long time there was a curious controversy amongst engineers as to the two methods of removing the heat produced by compression. It was maintained that the water injection would wet the air, but the lecturer showed, by expanding a cubic foot of air at 100 lbs. pressure per square inch standing over water in the theatre of the Institution, that, on emerging from the iron bottle containing it, it was exceedingly dry, which indeed followed from the fact discovered by Dalton that saturated vapour is liquefied by compression at a constant temperature, in direct proportion to the degree of compression. In practice, however, especially at sea, the air pressure is kept about 50 lbs., and the dryness of the air is further ensured by passing it, on its way to the expansion cylinder, through an interchanger, around the outside of which the partially cold air flowing to the compressor is made to circulate.

A number of large diagrams and a complete model were shown, showing the general construction of the cold-air machines used for importing meat into Great Britain, all of which were now manufactured after the general designs introduced by the lecturer a few years ago, and described to the Institution of Civil Engineers in his paper read there in February, 1862.

By means of these machines Australian, River Plate, and New Zealand mutton comes into Great Britain at the rate of 18,000 sheep, or 400 tons, per week, which represents a weekly procession a mile long and ten abreast. The quantity of American meat carried by the machines is still larger, so that the British householder is now supplied by them with meat to the value of between £4,000,000 and £5,000,000 *per annum*, calculated at the price of meat in retail shops.*

These machines, in an ordinary way, supply streams of atmospheric air cooled to about 80° below zero° F. (−63° C.), but by certain modifications they can be adjusted to deliver the air cooled much lower, and, in point of fact, to as low temperatures as have yet been produced in physical researches.

For the purposes of the conjoint experiments with Prof. McKendrick, a machine, worked by a gas motor engine, capable of delivering 30 cubic feet of air (0·84 cub. metre) per minute, was employed, the cold air being made to pass upward in a square vertical shaft of wood, in the sides of which were apertures regulated by valves, and by means of which about a dozen chambers, each of 3 cubic feet capacity (0·084 cub. metre), could be maintained at any particular temperature desired. These temperatures were carefully taken by an absolute alcohol thermometer, made by Negretti and Zambra, and checked by a special air thermometer devised by Mr. Coleman.

The experiments consisted in exposing for hours to low temperatures putrescible substances in hermetically sealed tins or bottles, or in flasks plugged with cotton-wool; the tins or flasks were then allowed to thaw, and were kept in a warm room, the mean temperature of which was about 80° F. (27° C.); they were then opened and the contents submitted to microscopical examination with magnifying

powers of from 250 to 1000 diameters. The general results were as follows:—

1. Meat in tins (4½ inches in diameter and 1 inch in depth), exposed to 80° below zero F. (−63° C.) for six hours, underwent putrefaction with generation of gases.*

2. Whilst these experiments were going on, comparative experiments were made with tins and bottles containing meat, but not exposed to cold. Under such circumstances the effects of storing them in the warm room for even the short period of a fortnight was to develop such large quantities of extremely foetid gas, and very active bacteria and vibrios, that there was no doubt whatever but that exposure to a cold of 80° below zero (63° C.) had checked their development to some extent in the subsequent exposure to a warm temperature.

3. On the 24th of December, 1884, thirty samples of fresh meat were placed in 2-oz. white glass phials. These were carefully corked with corks previously steeped in mastic varnish, and the necks of the corked bottles were then immersed in melted sealing-wax. These bottles were divided into five sets, and marked A, B, C, D, and E, and they were treated as follows:—

A.	6 samples	were exposed	to zero F. (−17° C.)	65 hours.
B.	6	"	" −20° F. (−29° C.)	"
C.	6	"	" −30° F. (−34° C.)	"
D.	6	"	" −40° F. (−40° C.)	"
E.	6	"	" −80° F. (−62° C.)	"

These experiments ended on 28th December. On the 29th one bottle from each group was again exposed to −80° F. (−63° C.) for six hours, then again frozen for six hours at −80° F. (63° C.). The whole of those were removed to the room, but in the meantime it was noticed that at temperatures below zero, and particularly so low as −80° F. (−63° C.), the meat assumed a peculiar dirty-brown appearance. In the course of a few hours, however, the whole of the samples assumed at normal temperatures the well-known reddish colour of meat. In all cases, however, in the course of ten or twelve hours after removal to the warm room, signs of putrefaction were visible, and in the course of a few days the putrefactive process was fully established. It is important to notice that the temperature reached in these experiments, namely, from −70° to −80° F. (−56° to −63° C.) is about the minimum degree of cold hitherto observed in Polar expeditions.†

4. It is well known that freezing muscle taken from a newly-killed animal prevents the coagulation of muscle-plasma, and that the plasma can, on partial thawing, be squeezed out of the muscle and allowed to coagulate. It occurred to the lecturers that if muscle were suddenly exposed to extreme cold, before cadaveric rigidity had set in, some change might be observed in the putrefactive process. Accordingly a rabbit was instantaneously killed, portions of its muscles were at once placed in stoppered bottles and transferred to the cold chamber, then having a temperature of about −80° F. They were kept there for ten hours; then allowed to thaw partially in the cold chamber, whilst the cold-air machine was not at work; then again frozen for twelve hours; and finally transferred to the warm room. In these circumstances they under-

* July, 1885.—At this date, which is eight months from the commencement of the experiment, several of the sealed-up tins are on hand; the bulging of the tins and apparently the generation of gases cease! after the first month, the organisms being apparently rendered inactive by their own effluvia, or from want of oxygen. There is now very little smell on opening the tins, but a large number of organisms are visible with a one-eighth inch object-glass—alive and active.—[J. J. C.]

† The lecturers have been favoured with the following remarks by Mr. Alexander Buchan, the eminent meteorologist, to whom they applied for information:—"So far as I am aware, or can discover, the temperature of −73·7° F. registered on board the *Alert* in March, 1876, is the lowest temperature yet observed anywhere in the free atmosphere. The lowest mean monthly temperature known is −55·8° F. for January, at Verchojansk (lat. 67° 34' N., and long 133° 51' E.) in north-eastern Siberia." It is possible that one or more of the individual observations that make up this low mean may have given a reading lower than −73·7° F.

* According to the Smithfield Market reports, 27,007 tons of mechanically cooled meat arrived from U.S. America in 1884, and 5500 tons Australian, New Zealand, and River Plate frozen mutton in first three months of 1885.

went rapid putrefaction. The samples seemed to be more moist than other specimens of ordinary butcher meat, and they certainly underwent more rapid putrefaction.

5. A further set of experiments with meat was carried out, in which the samples were continuously exposed to a temperature of from -90° to 120° F. (-83° C.) for 100 consecutive hours; the bottles were then removed to the warm room, with the result that in ten or twelve hours the putrefactive process seemed to be fully established.

5 a. It has been shown by Pasteur* that if putrescent or fermenting substances are sealed up in a comparatively small space containing air, the processes are arrested when all the oxygen has been used up, and the products of putrefaction may undergo no further alteration. In these circumstances, in such experiments as ours, the apparent arrest of putrefaction in sealed vessels might have been attributed to the action on the organisms of the low temperature to which they had been exposed, instead of to the real cause—the removal of all the oxygen from the confined air. To meet this difficulty the importance was seen of testing the effect of cold on putrescible substances placed in test-tubes and flasks firmly plugged with cotton-wool, through which there might be a free play between the gases in the tube or flask and the surrounding atmosphere. Nor was it necessary in such experiments to sterilise the cotton-wool by heat, as must be done in all researches on the effects of high temperatures, because if a low temperature were fatal to micro-organisms it would kill those in the cotton-wool as well as those in the putrescible substances. Many experiments were made with tubes and flasks stopped with cotton-wool plugs instead of being hermetically sealed, but there was no difference in the general result.

6. Six flasks were filled with fresh urine, and plugged with cotton-wool, on the 10th of December. The first one plugged with wool was exposed to the temperature of the engineering shop where the experiments were carried on (about 50° F.), and on the 13th the urine was muddy; on the 18th it was found to be swarming with bacteria and vibrios. The second was exposed for eight hours to zero F.; on the 13th it showed slight muddiness, and on the 18th it was swarming with bacteria. The third was exposed to a temperature of -10° F. for eight hours, and on the 18th it was also swarming with bacteria. The fourth was exposed to -20° F. with the same result. The fifth was exposed to -30° F. with a like result. The sixth was exposed to -80° F., and it did not become muddy until the 22nd,—that is, twelve days after the beginning of the experiment. These results showed that freezing at very low temperatures delayed the appearance of the alkaline fermentation due to organisms, but a temperature of -80° for eight hours did not sterilise the urine.

7. Samples of fresh milk, exposed to temperatures of from zero to -80° F. for eight hours, curdled, and showed the well-known *Bacterium lactis*, and, so far as could be observed, freezing did not delay the process after the flasks were kept at a temperature of about 50° F.

8. Samples of Prestonpans beer (containing about 2 per cent of alcohol) were similarly treated. Exposed to the air of the shop, a scum of torulæ made its appearance in three days. Freezing undoubtedly delayed the appearance of these in flasks plugged with cotton-wool, and the delay corresponded to the fall of temperature, so that the sample exposed to -80° F. did not show the scum for twenty-two days after its removal from the cold chamber. Still it could not be said that this degree and duration of cold sterilised the fluid.

9. Samples of sweet ale behaved in a precisely similar manner.

10. Samples of meat juice, made by boiling lean meat, filtering, and carefully neutralising, were also operated on, both in flasks hermetically sealed and having the necks stuffed with cotton-wool. Exposed to temperatures of from zero to -80° F. for eight hours, all of these in due

time showed, under the microscope, numerous bacteria, but the freezing process undoubtedly delayed their appearance, and this was most marked in the samples exposed to the lowest temperatures.

11. Samples of neutralised vegetable infusion behaved in a similar way.

12. Many experiments were made with putrefying fluids, full of bacteria and other micro-organisms. The method followed was to examine the fluid with the microscope, and to note the appearances of the organisms. Then portions of the fluid were placed either in a flask plugged with cotton-wool or in a hermetically-sealed flask, and exposed to the lowest temperature attainable,—namely, -120° F. In one set of experiments such organisms were exposed to -120° F. for 100 consecutive hours. The thawed fluid was again examined microscopically, with the result of showing that the organisms were motionless. Still it could not be asserted that they, or at all events their spores, were dead, as, after exposure to a temperature of 80° F. for a few hours, the fluid was found to be again teeming with organisms in active movement. The conclusion arrived at was that such prolonged exposure to cold did not kill them all, probably leaving spores unaffected.

13. It was also attempted, by repeated freezings and thawings, to kill micro-organisms, as it was conceivable that cold might kill the adults only, leaving the spores unaffected. If, then, the spores were killed as they approached maturity, and before they had produced new spores, it might be possible to sterilise the fluid. All attempts in this direction were unsuccessful.

14. Experiments were also made with gelatinous infusions of meat, to which grape sugar had been added. Exposure to low temperatures and thawing did not destroy the gelatinous character of the substance, but putrefaction was not prevented. Such gelatinous masses, after exposure for 100 consecutive hours to -120° F., and subsequently for fifteen to twenty hours in a warm room of 80° F., became filled with bubbles of imprisoned gas, each bubble being the outcome of one or more organisms.

15. It is a striking consideration that freezing at low temperatures makes a mass of organic matter solid throughout, so that it can only be broken to pieces by violent blows of a hammer. Beef has then a fractured surface like a piece of rock. Mutton is friable. Still, when such a mass—say a piece of muscle—is thawed, its microscopical structure seems to be unaltered. All that can be said is that it is moister than ordinary fresh muscle. It is probable, therefore, that the bodies of micro-organisms are also frozen solid, and yet they apparently may live for a long time in this condition. One cannot suppose that in these circumstances any of the phenomena of life take place; the mechanism is simply arrested, and vital changes may again occur when the conditions of a suitable temperature return. Such considerations led the lecturers to examine whether any of the vital phenomena of higher animals might be retained at such low temperatures. It was ascertained that a live frog may be frozen quite solid throughout at a temperature of from -20° F. to -30° F. in about half an hour. On thawing slowly, in two instances, the animal completely recovered. When kept in the cold chamber longer than half an hour the animal did not recover, but the muscles and nerves were still irritable to electricity, responding to weak induction shocks. Reflex action, however, was abolished. In two cases frogs were exposed for twenty minutes to a temperature of -100° F. On thawing they did not recover, but the muscles still feebly responded to electrical stimulation, showing that their irritability had not disappeared. The probability is that longer exposure to this temperature, or exposure for a shorter time to a lower temperature, would destroy muscular and nervous irritability; but it is a striking fact that irritability can survive to any degree a transition through a state of solidity produced by cold.*

* *Comptes Rendus*, lvi., 734-1189. See also article "Fermentation," Watts's "Dictionary of Chemistry," First Supplement, p. 612.

* Kühne observed that a frozen frog's muscle will contract after thawing, but the temperatures he reached were not low.

16. One experiment was performed on a warm-blooded animal—a rabbit. Before the experiment, the temperature of the rectum was 99.2° F., pulse 160 per minute, respirations about 45 per minute. At 10.30 a.m. it was placed in the cold chamber, the thermometer of which stood at -93° F. At 11 a.m. it was removed for a minute or two; it did not seem to be affected, but the temperature of the rectum was now 94.2° , a fall of 5° in half an hour. It was then re-introduced into the cold chamber, the temperature of which was read off at -100° F. It was taken out at 12 noon; it seemed to be comatose; reflex action was abolished; there were jerking movements of the limbs; its rectal temperature was now 43° F., a fall of 51° during the hour; its pulse was 40 per minute, being a fall of 120, and its respirations were barely perceptible. It was placed in a warm place, and it began slowly to recover. In fifteen minutes its temperature had risen to 72° F., in ten minutes more to 89° F. Its pulse beats when removed from the chamber were 40 per minute, in 15 minutes they had risen to 60 per minute, and in fifteen minutes more to 100 per minute. The animal completely recovered. When removed from the chamber at 12 noon, although reflex action was abolished, the muscles were still irritable to electrical stimulation, and on placing the wires over the sciatic nerve without cutting the skin, strong spasms of the muscles of the leg were caused, showing that the nerve was still irritable. It follows, therefore, that some of the effects of the extreme cold were due to the inactivity of the nerve centres. Consciousness and reflex action were abolished, owing to inactivity of the grey matter of the encephalon and of the spinal cord.

The effect of the extreme cold on the warm-blooded or homoiothermal animal, as contrasted with its effect on the cold-blooded or poikilothermal animal, is very striking. The cold-blooded frog became as hard as a stone in from ten to twenty minutes, and the temperature of its body was probably the mean temperature of the chamber; the warm-blooded animal produced in itself so much heat as enabled it to remain soft and comparatively warm during exposure of an hour's duration to -100° F. Still its production of heat was unequal to make good the loss, and every instant it was losing ground, until, at the end of the hour, its bodily temperature had fallen about 56° F. below its natural temperature. Had it been left in the chamber long enough, its bodily temperature would have fallen until it reached the temperature of the cold chamber, and it would then have become as hard as the frozen frog. It is remarkable, however, that even at the end of an hour's exposure to -100° F., its bodily temperature was 143° above -100° F. As blood freezes and the hæmoglobin crystallises at about 25° F., had the temperature of the body fallen below that point, the animal would not have recovered, as its blood would have been destroyed.

The lecturer observed that several researches had been made prior to those of himself and Professor McKendrick on the influence of cold, none of them, however, very decisive as regards the microphytes concerned in the putrefactive processes. Thus, before 1872, we find Dr. Ferdinand Cohn* stating that he had subjected bacteria to low temperatures without destroying their activity. He gives the temperatures as follows:—Exposure for twelve hours thirty minutes to a temperature 0° C.; for one hour thirty minutes to -16° C.; for one hour forty-five minutes to -17° C.; for three hours thirty minutes to -18° C.; for four hours thirty minutes to -18° C.; for five hours to 17.5° C.; for six hours to -14° C.; and for seven hours thirty minutes to -9° C. He produced the cold by freezing mixtures, and the lowest temperature he obtained was -18° C. = 0° F. In 1870–71, M. Melsens exposed yeast and vaccine lymph to very low temperatures (-78° C.), by means of solid carbonic acid, without destroying the power of fermentation or inoculation.†

* Cohn's *Beiträge zur Biologie der Pflanzen*, 1870, Zweites Heft., p. 221.

† Melsens, *Comptes Rendus*, tome lxx., 1870, p. 629; also tome xxi., p. 325.

Klein* states that "Freezing destroys likewise most bacteria, except the spores of bacilli, which survive exposure to as low a temperature as -15° C., even when exposed for an hour or more." Again, in another place† he says: "Exposing the spores of anthrax-bacillus to a temperature of 0° to -15° C. for one hour did not kill them."

In 1884 a remarkable series of experiments were described to the French Academy by MM. R. Pictet and E. Yung.‡ These observers sealed up in small glass tubes fluids containing various kinds of microphytes, and placed them in a wooden box. The box was in the first place submitted for twenty hours to a cold of -70° C., produced by the evaporation of liquid sulphurous acid *in vacuo*. The box was then surrounded by solid carbonic acid for 89 hours, and a cold of from -70° to -76° C. was thus obtained. Finally, the box was subjected for a third period of 20 hours to a cold produced by the evaporation of solid carbonic acid *in vacuo*,—the temperature being estimated at from -76° to -130° C.—that is, a minimum temperature of 202° below zero F. They sum up by stating that the organisms were acted on by a cold of -70° C. for 109 hours, followed by a temperature of -130° for 20 hours. The organisms tested were *Bacillus anthracis*, *Bacillus subtilis*, *Bacillus ulna*, *Micrococcus luteus*, and a micrococcus not determined. *Bacillus anthracis* retained its virulence when injected into a living animal. The vitality of the others was not affected. Experiment showed that, whilst cold seemed to kill some of the micrococci, a great number resisted it. Yeast showed no alteration under the microscope, but it had lost its powers of fermentation. Vaccine lymph exposed to the low temperatures did not produce a pustule on the left arm of an infant, whilst another sample of the same lymph introduced into the right arm of the same child produced a pustule. Pictet and Yung conclude from their experiments that, in the conditions of cold indicated, many of the lower organisms were not destroyed.||

From this consensus of evidence, Mr. Coleman observed, it then appears that any hope of permanently sterilising meat by cold (the counterpart of Appert's process by heat) must be abandoned, but it is quite possible that at some point near absolute zero the vitality of all microphytes may be destroyed.

The persistency, however, of their vitality between great extremes of temperature, ranging in fact through 400° F., is very remarkable, and is in marked contrast to their susceptibility to destruction by moist ozone, peroxide of hydrogen, and by sunlight or diffused daylight.§

There can be no doubt about disease germs being pestiferous, but it is quite possible the function of many microphytes is beneficent, preventing the undue accumulation of dead organic matter, though it is not quite clear that they are absolutely essential as a preliminary to its oxidation, and on this and kindred subjects there is much work yet to be done by the united labour of the physicist, chemist, and physiologist.

Formation-Heat of Antimony Bromide and Iodide.
M. Guntz.—The formation-heat of antimony bromide proceeding from solid antimony and gaseous bromine is $+76.9$ cal. That of antimony iodide under the same conditions is $+45.6$ cal.—*Comptes Rendus*, vol. ci., No. 2.

* Klein, "Micro-organisms," p. 35.

† Klein, *op. cit.*, p. 73.

‡ *Comptes Rendus*, tome xcvi., No. 12 (24 Mars, 1884), p. 747.

§ In a letter to Dr. McKendrick, Professor Arthur Gamgee states that some months ago he exposed putrescible fluids to moderate degrees of cold without thereby preventing putrefaction, and that he abandoned the research as unlikely to lead to any important result with the temperature he had at command. It is also stated in Landois's "Physiology," translated by Stirling, vol. i., p. 456, on the authority of Frisch, that "bacteria survive a temperature of -87° C.; yeast even -100° C."

§ "Researches on the Effect of Light upon Bacteria and other Organisms," by Arthur Downes, M.D., and J. P. Blunt, M.A., *Proc. Roy. Soc.*, xxvi., 1877.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.
(Continued from p. 51).

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
|| Following a date signifies publication discontinued.

101. JAHRESBERICHT ÜBER DIE FORTSCHRITTE DER CHEMISCHEN TECHNOLOGIE für Fabrikanten, Hütten und Forstleute, Cameralisten, Chemiker und Pharmaceuten. Herausgegeben von Joh. Rud. Wagner. 6 vols., 8vo. Leipzig, 1855-'60.

Continued under the title:

[a] Jahresbericht über die Fortschritte und Leistungen der chemischen Technologie und technischen Chemie. Herausgegeben von J. R. Wagner. 9 vols. (vii.-xv.), 8vo. Leipzig, 1861-'69.

Continued under the title:

[b] Jahresbericht über die Fortschritte und Leistungen der chemischen Technologie und technischen Chemie, (from vol. xviii.), mit besonderer Berücksichtigung der Gewerbestatistik. Herausgegeben von J. R. Wagner, Neue Folge. 11 vols. (xvi.-xxvi.), 8vo. Leipzig, 1870-'80.

Continued under the title:

[c] Wagner's (R. von) Jahresbericht über die Leistungen der chemischen Technologie, mit besonderer Berücksichtigung der Gewerbestatistik für das Jahr 1880-'83. Herausgegeben von F. Fischer. 3 vols., 8vo. Leipzig, 1881-'84+

General-Register über Band 1 bis 10, bearbeitet von Fr. Gottschalk. 1 vol., 8vo. Leipzig, 1866.

General-Register über Band 11 bis 20, bearbeitet von Fr. Gottschalk. 1 vol., 8vo. Leipzig, 1876.

JAHRESBERICHT ÜBER DIE FORTSCHRITTE DER CHEMIE DES BODENS. See Jahresbericht über die Fortschritte der Agriculturchemie.

JAHRESBERICHT ÜBER DIE FORTSCHRITTE DER CHEMIE DER PFLANZE. See Jahresbericht über die Fortschritte der Agriculturchemie.

JAHRESBERICHT ÜBER DIE FORTSCHRITTE DER CHEMIE DER THIERNÄHRUNG. See Jahresbericht über die Fortschritte der Agriculturchemie.

102. JAHRESBERICHT ÜBER DIE FORTSCHRITTE DER PHYSISCHEN WISSENSCHAFTEN. Von Jacob Berzelius. Aus dem schwedischen übersetzt von C. G. Gmelin [later,] und F. Wöhler. 20 vols., 8vo. Tübingen, 1822-'41.

Continued under the title:

[a] Jahresbericht über die Fortschritte der Chemie und Mineralogie. Eingereicht an die schwedische Akademie der Wissenschaften. Von Jacob Berzelius. [From 1849-'51, edited by L. F. Svanberg.] Aus dem schwedischen übersetzt von F. Wöhler. 10 vols. (xxi.-xxx.), 8vo. Tübingen, 1842-'51. || Register. Vols. 1.-xvii., 1839; 1.-xxv., 1847.

Cf. Årsberättelse om Framstegen i Fysik och Kemi; also, Annuaire des sciences chimiques; also, Rapport annuel sur les progrès des sciences physiques et chimiques.

103. JAHRESBERICHT ÜBER DIE FORTSCHRITTE DER REINEN, PHARMACEUTISCHEN UND TECHNISCHEN

CHEMIE, Physik, Mineralogie und Geologie. Unter Mitwirkung von H. Buff, E. Deffenbach, C. Ettling, F. Knapp, H. Will, F. Zamminer. Herausgegeben von Justus Liebig und Hermann Kopp, 1847-'56. 9 vols., 8vo. Giessen, 1849-'57.

Continued under the title:

[a] Jahresbericht über die Fortschritte der Chemie und verwandter Theile anderer Wissenschaften. Von Hermann Kopp und Heinrich Will. [In 1864, unter Mitwirkung von Th. Engelbach, W. Hallwachs, A. Knop, herausgegeben von Hermann Kopp und Heinrich Will. In 1864, unter Mitwirkung von C. Bohn und Th. Engelbach, herausgegeben von Heinrich Will. In 1868, unter Mitwirkung von Th. Engelbach, Al. Naumann, W. Städel, herausgegeben von Adolph Strecker. In 1870, unter Mitwirkung von K. Birnbaum, W. Dittmar, F. Hoppe-Seyler, A. Laubenheimer, A. Michaelis, F. Nies, Th. Zincke, K. Zöppritz, herausgegeben von Alexander Naumann. In 1875, unter Mitwirkung von K. Birnbaum, C. Boettinger, C. Hell, H. Klinger, A. Laubenheimer, E. Ludwig, A. Michaelis, A. Naumann, F. Nies, H. Salkowski, Zd. H. Skraup, K. Zöppritz, herausgegeben von F. Fittica. In 1882, unter Mitwirkung von A. Bornträger, A. Elsas, E. Erdmann, C. Hell, H. Klinger, E. Ludwig, A. Naumann, F. Nies, H. Salskowski, G. Schulz, herausgegeben von F. Fittica.] 1857-'82. 26 vols. (x.-xxxv.), 8vo. Giessen, 1858-'84+

Since 1847, also under the title:

Jahresbericht über die Fortschritte der reinen, pharmaceutischen und technischen Chemie, Physik, Mineralogie, und Geologie. Bericht über die Fortschritte der Chemie und verwandter Theile anderer Wissenschaften.

Accompanied by:

Jahresbericht über die Fortschritte der Physik, von Friedrich Zamminer. Für 1857. 1 vol., 8vo. Giessen, 1858.

Register zu den Berichten für 1847 bis 1856. 1 vol., 8vo. Giessen, 1858.

Register zu den Berichten für 1857 bis 1866. 1 vol., 8vo. Giessen, 1868.

Register zu den Berichten für 1867 bis 1876. 1 vol., 8vo. Giessen, 1880.

(To be continued).

NOTE ON THE
PRESENCE OF CAFETANNIC ACID,
CITRIC ACID, AND QUERCITRIN IN
CISSUS QUINQUEFOLIA.

By Dr. T. L. PHIPSON, F.C.S., &c.

THE "Virginia creeper" or Vigne vierge (*Cissus quinquefolia*, Desf.), a plant of the Vine family, is now commonly cultivated upon the walls of houses and gardens, and is noticeable by the bright red hue it assumes in autumn. Having allowed it to spread over an iron network for the space of two seasons, I found it attacked the metal in a very remarkable manner,—in fact eating it quite away in places, and at others covering it with a crust of some basic salt of iron, beneath which the wire was so thin as to break under the slightest pressure.

On tasting the leaves I found them exceedingly acid. On the leaves being allowed to remain in water for forty-eight hours the water became very acid, and was found to

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

contain *citric acid* in notable quantity, with a small quantity of tartaric acid and a large amount of *cafetannic acid*. After this water was separated from the leaves, and they were treated with a dilute solution of soda hydrate, they yielded a yellow liquid very rich in *quercitrin*, or a kind of quercitrin (for there appear to exist several varieties of this glucoside in the vine, the nettle, the horse-chestnut, and many other plants).

A certain quantity of the leaves and stalks being allowed to steep for some forty-eight hours in cold water, and the water then poured off clear, or filtered, is found to be very acid. It neutralises an amount of carbonate of soda equal to 2.18 acid (calculated as citric acid) per cent of the fresh leaves and stalks. To separate the citric and tartaric acids the liquid is boiled with carbonate of lime (precipitated chalk) and filtered hot. The cafetanate of lime remains in solution, forming a golden yellow liquid.

If, instead of this, the liquid be saturated with carbonate of soda, of which a slight excess is added, and evaporated almost to a syrupy mass, then allowed to remain exposed to the air for about forty-eight hours, a large quantity of *viridic acid* is formed, or viridate of soda, in well-defined crystals,* producing a dark green substance which dissolves in hydrochloric acid, yielding a fine *purple-red* solution (this is characteristic). Well-defined rhombic crystals of basic citrate of soda can also be obtained from this evaporation product.

After the action of pure water, weak solution of hydrate of soda extracts from the same leaves an abundance of *quercitrin* before any of the chlorophyll of the leaf is taken up.

The dark green viridate of soda dissolves in acids,—for instance, hydrochloric acid,—forming a fine purple-red solution, which becomes green again when saturated with soda, or ammonia, &c. If this purple-red solution, containing 2 or 3 per cent of hydrochloric acid, is boiled for some time, the viridic acid splits up into an insoluble brown crystalline or amorphous powder and other products, whilst a peculiar odour is diffused, resembling that of essence of turpentine, and some oily films are found on the dark-coloured liquid after cooling.

I am of opinion that viridic acid is formed when perchloride of iron is added to solution of cafetannic acid, and probably with other kinds of tannin which produce a green colour with per-salts of iron.

Putney, London, S.W.
August 1, 1885.

THE BIOLOGICAL EXAMINATION OF WATER.

By C. J. H. WARDEN, Surg. H.M.'s Bengal Army,
Professor of Chemistry, Calcutta Medical College.

(Continued from p. 54.)

II. Preparation of Reagents.

Meat Peptone Gelatin.*—A ten per cent solution of gelatin in meat juice is perhaps the best strength for water analysis; it is prepared as follows:—Juicy lean meat, carefully freed from fat, is to be chopped up fine, and 250 grms. placed in a beaker with 500 c.c. of cold distilled water. The vessel is then covered, and the mixture allowed to stand for twelve hours in a cold place. In warm weather the mixture should be kept in a refrigerator at a temperature of about 15° C. to prevent decomposition.

Place a clean strong cloth of fine material over a funnel, and pour on it the meat mixture, collecting the filtrate in a graduated cylinder of 500 c.c. capacity. Press the meat

until the cylinder contains 400 c.c. If this amount cannot be obtained by manual pressure, the cloth and its contents may be pressed in a small meat-press until the requisite amount of juice has been expressed. As meat-presses are not always available, the pulp in the cloth may be moistened with a small amount of cold distilled water, and re-pressed until the requisite amount of liquid has been obtained.

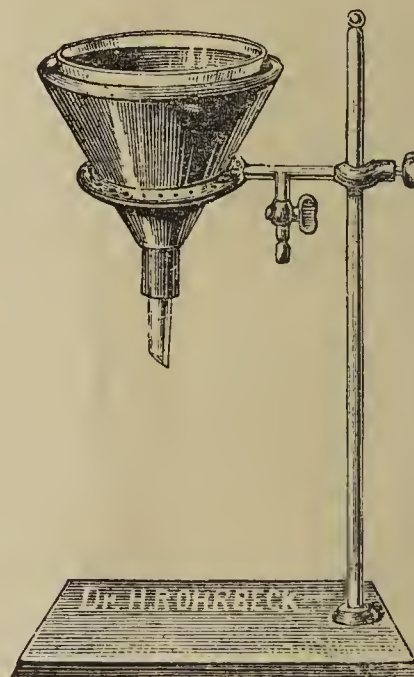
Pour the 400 c.c. of juice into a wide-mouthed flask, and add:—

* Gelatin	40 grms.
Peptone.. .. .	4 "
Common salt	2 "

Plug the flask with cotton-wool, and allow it to stand on a water-bath at a temperature of 50°–60° C., with occasional agitation, until the gelatin has dissolved, and an uniform mixture results. Direct application of a flame to the bottom of a flask must be avoided, because the gelatin, being in a viscid condition, is liable to burn, and because the temperature of the fluid at this stage of the process must not reach the point at which albumen coagulates.

When the gelatin has completely dissolved, the liquid must be neutralised by carbonate of soda. The carbonate

FIG. 10.



of soda in strong solution is cautiously added with constant agitation, until a drop of the liquid placed upon red litmus-paper gives a *slight blue* reaction. With blue litmus-paper there should be no reddening.

The flask containing the neutralised juice is again plugged and heated to 100° C. in a water-bath, and kept at that temperature for about half an hour. During the heating the albumen is coagulated, and rises to the surface as a dense coagulum. Care should be taken to avoid agitating the liquid, which would cause the coagulum to break up into fine particles, and thereby render the subsequent filtration difficult. If the heat has been applied sufficiently long to coagulate the whole of the albumen the liquid presents the following appearance:—On the surface there is a dense whitish coagulum, while the liquid below is bright, transparent, and yellowish.

The coagulum is to be removed by filtration through fine muslin, and the somewhat turbid filtrate is then to be passed through a moistened ribbed paper filter, surrounded with a hot-water jacket (Fig. 10), the liquid being received

* Best seen under a microscope of moderate power.

* Carefully prepared and sterilised meat peptone gelatin can be obtained from Dr. H. Rohrbach, of Berlin, in test-tubes containing 10 c.c., at 1 mark for 5 tubes, or in flasks at the rate of 2.50 marks for 250 grms.

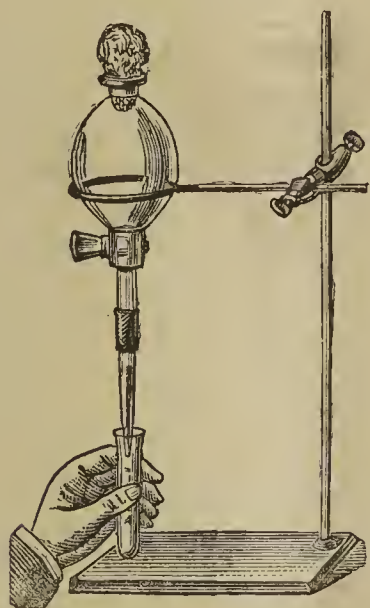
* Ordinary gelatin does not answer well; that sold in thin transparent sheets, manufactured in France, *premiere qualité*, is best adapted for this purpose.

into a flask. During filtration the mouth of the funnel should be covered with a glass plate. It is always advisable, before commencing the filtration, to re-test the reaction of the liquid, and if it be found acid to neutralise. It often occurs that the first portions of the liquid which pass through the filter are turbid, in which case the filtrate must be returned to the filter, and this must be repeated until it filters bright.

The flask containing the clear filtrate is plugged and placed on a sand-bath, and the contents boiled rapidly for ten minutes; or the flask may be placed in the steam sterilising apparatus, and heated to 100°C . for half an hour. After this heating, the liquid, while still hot, is to be decanted into the sterilised test-tubes, either directly from the flask or by means of the apparatus, Fig. 11.

In order to fill a test-tube, remove the cotton-plug, taking care not to place it upon the table, but to hold it between the fingers, and to avoid touching that portion which fits into the tube. The tube should then be filled rapidly about one-third with the liquefied gelatin, and immediately re-plugged. After a sufficient number of tubes have been filled, the contents must be sterilised, and this may be done in one of two ways,—by packing the tubes in the tin vessel (Fig. 9), closing the cover, and heating to 100°C . in the steam sterilising apparatus for

FIG. 11.



thirty-five minutes, on three occasions, at intervals of twenty-four hours; or the contents of each tube may be boiled for five minutes over a flame on three occasions at intervals of twenty-four hours. The first-described method is the less troublesome, and is to be recommended.

This method of *fractional sterilisation* has been shown by Pasteur to be surer than the same amount of continuous heating. After sterilisation the tubes should be kept standing on a layer of cotton-wool contained in a beaker or other convenient vessel. The gelatin mixture will remain fit for use for two or three months, but care should be taken to prevent evaporation by slipping over the plug a small cap of caoutchouc.

Sterilised distilled water may be prepared by either direct boiling or in the steam sterilising apparatus. In either case fractional sterilisation must be adopted, the procedure being similar to that employed for the sterilisation of gelatin. Sterilised distilled water is used in certain cases for diluting a sample of water before admixture with gelatin. The sterilised distilled water is best prepared and preserved in test-tubes or small flasks of one or two ounces capacity.

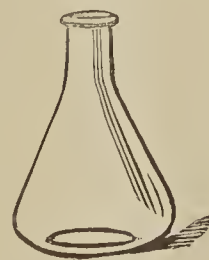
Bouillon is necessary if the development of micro-organisms in capped slides is to be watched. It is prepared from meat-juice, with the addition of 4 per cent peptone, but no salt or gelatin is added: it is neutralised

and sterilised in the same manner as the peptone gelatin, but does not require a hot-water jacket during filtration. It is best preserved in small sealed tubes, holding about 20 or 30 c.c. When required for use the contents of a tube may be emptied into a sterilised test-tube, and if the precaution be taken to boil the contents of the tube for a few minutes each time the cotton-wool plug is removed to withdraw a drop, the bouillon will keep sound for weeks.

Sterilised potatoes may be required in certain cases for the cultivation of micro-organisms which occur in water, in order to distinguish between varieties which possess similar morphological characters. For instance, several varieties of comma-shaped bacilli are known, among which is the cholera bacillus, but its mode of growth on sterilised potatoes under different physical conditions is one of the points which serve to distinguish it from other similar shaped organisms. Potatoes are prepared for use in the following manner:—They are first well scrubbed with a brush and plenty of water to remove adherent earth, &c.; the "eyes" are cut out, and the potatoes soaked for forty or fifty minutes in a 2 per 1000 aqueous solution of sublimate; washed again, placed in the tin vessel (Fig. 9), and heated in the steam sterilising apparatus at 100°C . for one hour. The vessel is then removed from the steam-bath, and the contents allowed to cool with the cover on.

Aniline colours are employed for staining the bacilli. Methylen blue, gentian-violet, or fuchsine may be used, but the first-mentioned dye is the most useful. For permanent mounted cover glass preparations, however,

FIG. 12.



methylen-blue has the disadvantage of fading more rapidly than the other colours. About 2 grms. of the dye should be rubbed up in a mortar with 10 c.c. of absolute alcohol, 50 c.c. of distilled water gradually added, and the mixture filtered through paper into a bottle provided with a perforated cork carrying a pipette, by means of which a small amount of the dye solution can be removed as required. Or saturated alcoholic stock solutions of the dyes can be prepared and diluted in the proportion of 1 to 9 with distilled water. A small fragment of camphor should be placed in the filtered solution; it prevents the formation of mould, and also appears to favourably influence the colouration of the bacilli.

III. Collection of Samples.

I would strongly recommend that the collection of samples should always be personally conducted, as special precautions must be taken to avoid accidental contamination of the water with foreign germs. Unless the operator be certain that the sample has not been contaminated the results of the analytical process are worthless. Micro-organisms are naturally present in air, water, and on every surface which has been exposed to the atmosphere, and it is quite conceivable that a person unacquainted with methods of bacteriological research might use distilled water to clean a flask intended for the reception of a sample for biological examination, under the impression that, because distilled water is nearly chemically pure, it must also be germ free. But as a matter of fact ordinary distilled water, as found in laboratories, teems with micro-organisms.

The sources from which water may have to be drawn

for bacteriological examination may be arranged under the following heads:—

- A. Hydrant or tap water.
- B. Water of rivers and lakes.
- C. Well waters.

It may be laid down as a general rule in drawing a sample, that, whatever be the source from which the sample is taken, contact of the water with vessels other than the sterilised flasks in which it is to be preserved should be avoided.

In the Gesundheits Amt, Berlin, Erlenmeyer's flasks (Fig. 12), of about 4 ounces capacity, are used for the collection of samples. The flasks are cleaned, plugged, and sterilised in the same manner as the test-tubes used for holding the meat peptone gelatin. When cold, over the mouth and cotton-plug of each flask a tightly-fitting cap of black caoutchouc is fixed, and in this state the flasks are issued.

When it is necessary to take a sample of water from a tap, or "stand-pipe," the water should be allowed to flow in a full stream for about ten minutes. The rate of flow is then diminished, and the cap of caoutchouc and plug removed from the mouth of the flask, and the water allowed to flow directly into it until it is about two-thirds full, and the plug and cap immediately fixed. The mouth of the flask should not be allowed to come into contact with the tap.

In collecting a sample of river or lake water the neck of the flask is preferably fixed in a clean split stick; the flask is then inverted, and the cap and plug removed, and the flask forced below the surface of the water; the position is then reversed, and the flask removed filled with water. A small portion of the contents is then poured off, and the flask immediately re-plugged and capped.

In collecting a sample of water from sources included under the heading B, care should be taken to avoid the proximity of the banks, outlets of drains, &c.—unless there be special reasons. Probably a sample taken from the middle would represent better the normal condition of the water. But, obviously, should the water be drawn for domestic purposes from a landing-place, or from the banks, then a sample should be taken from that locality, and a second from mid-stream, and both examined. When a sample is drawn from a boat it should be taken from the bows.

In drawing a sample from a well the flask should have a loop of twine fixed round the neck, and a second one lower down around the body; the string by which the flask is lowered being attached to the upper loop, and a short length with attached weight, as a sinker, to the lower loop, but tied on the opposite side to the twine by which the flask is lowered.

The method of collecting samples in Erlenmeyer's flasks is only applicable when the transport of the flask without inversion can be assured: when samples have to be forwarded long distances the method must be modified. As the amount of water necessary for a biological examination is small, bulbs of glass, of about 5 or 6 c.c. capacity, can be used for collection and transport. A bulb of approximately the requisite size is blown at one end of a piece of soft glass tubing, 6 inches in length. The tube is now held by a pair of forceps, and the bulb and whole of the tube strongly heated; the open orifice is then fused, and drawn out into a capillary tube of about 2 inches in length, and the end sealed by fusing the glass. Tubes of this form suitably packed in cotton-wool may be sent long distances by post with safety. They are filled in the following manner:—Hold the tube a short distance above the bulb, and pass the capillary and upper part of the tube repeatedly through a flame. Allow the end to become quite cold, care being taken during the cooling to avoid contamination. Then plunge the capillary end about 2 inches below the surface of the sample, and with a pair of previously sterilised forceps nip off the end below the level of the water. As the tube was

sealed while hot, and therefore partly exhausted of air, when the end is opened below the surface of water a certain quantity enters. The tube is now removed and the bulb held downwards, and, with one or two jerks, any drops remaining in the capillary end shaken down; the capillary orifice is then closed by fusing the glass, and the tube thus hermetically sealed.

Another method of preparing bulbed tubes for the collection of samples is as follows:—After a bulb has been blown a small amount of sterilised distilled water is introduced, and the open end drawn out into a capillary tube. The water in the bulb is then boiled, and after a short time the bulb removed from the source of heat, and the capillary end sealed at the moment ebullition ceases. By this plan a better vacuum is obtained.

(To be continued.)

ON THE SEPARATION OF TITANIUM AND ALUMINUM, WITH A NOTE ON THE SEPARATION OF TITANIUM AND IRON.*

By F. A. GOOCH.

(Concluded from p. 57.)

THE incompleteness of the precipitation of alumina by the basic acetate process in presence of a large excess of acetic acid, suggested the attempt to hold up alumina entirely by means of a sufficient excess of acetic acid while precipitating titanium. Experiments to determine the amount of acetic acid necessary to prevent the precipitation of alumina from a boiling solution of the acetate, indicate that amounts of absolute acid in excess of 5 per cent by volume of the solution are adequate to the purpose, and that the addition of sodic acetate in reasonable amounts does not sensibly affect conditions. It appears, further, that the addition of a very small quantity of titanium in solution to the clear boiling solution of alumina in acetic acid occasions at once a perceptible precipitation. Thus, 0.0005 grm. of titanous oxide in solution produced a distinct and appreciable opalescence in 500 c.m.³ of liquid containing 10 grms. of alum, 15 grms. of sodic acetate (about twice the amount necessary to convert the sulphate of alumina to the acetate), and 7 per cent by volume of absolute acetic acid.

In respect to holding up alumina, formic acid acts like acetic acid, but more potently.

In the following experiments to test the method quantitatively, two solutions of titanium were employed:—In (40) and (41), the solution the value of which was fixed by (15) to (18); in (42) to (46), the solution whose standard was set by (24) to (27). To the cold solution of titanium containing a little free sulphuric acid together with some alkaline sulphate were added 5 grms. of alum (approximately 0.5 grm. of alumina), 20 grms. of sodic acetate, which was always more than enough to effect the entire conversion of the aluminic and titanous sulphates to acetates, acetic acid to such amount that in experiments (42), (43), (44) there should be in the solution 7 per cent by volume of absolute acid, and in the remaining experiments 10½ per cent by volume, and water to make the entire volume 250 c.m.³ in (40) and (41), and 400 c.m.³ in the rest. The clear solutions obtained in this manner were raised quickly to boiling, kept at that point for a minute, and removed from over the burner so that the precipitate might settle,—as it does almost immediately. The supernatant liquid was decanted upon a filter sufficiently porous to permit very rapid filtration,† and the precipitate added immediately

* From the *Proceedings of the American Academy of Arts and Sciences*, New Series, vol. xii.

† The paper No. 589 of Schleicher and Schüll is excellent for the purpose.

thereafter, and washed with 7 per cent acetic acid, followed finally by hot water. The washed precipitate was dried, ignited, and weighed. The precipitate once upon the filter and drained becomes more compact and easily washed, and strong ignition of fifteen or twenty minutes over a good Bunsen burner, after the paper is thoroughly ashed, reduces it to a weight which neither the blast-lamp nor ignition in an atmosphere of ammoniac carbonate changes.

	Weight of Solution. Grms.	TiO ₂ found. Grm.	TiO ₂ by Standard. Grm.	Error. Grm.
{ (40)	10.4910	0.0645	0.0618	0.0027 +
{ (41)	10.5970	0.0656	0.0624	0.0032 +
{ (42)	20.9520	0.1450	0.1343	0.0107 +
{ (43)	21.1750	0.1439	0.1357	0.0082 +
{ (44)	21.0250	0.1431	0.1347	0.0084 +
{ (45)	20.8740	0.1393	0.1338	0.0055 +
{ (46)	21.0570	0.1402	0.1349	0.0053 +

It is quite obvious that a single precipitation by the method used does not yield titanic oxide free from alumina. The weighed precipitate of each experiment was therefore fused with a small quantity of sodic carbonate, and the product of fusion treated in the crucible with strong sulphuric acid, which gradually, with the aid of gentle heat, dissolved everything completely. This solution after cooling was poured directly into 100 c.m.³ of cold water, and, the liquid remaining clear, ammonia was added just to alkalinity, and then dilute sulphuric acid corresponding to 2.5 grms. of pure acid. The precipitate thrown down by ammonia was gradually, but after a few minutes entirely, re-dissolved, acetic acid was added until it amounted in terms of absolute acid to 10½ per cent of the entire volume, 20 grms. of sodic acetate introduced, the solution boiled, and the precipitate treated as previously described. The results of this second treatment are given below:—

	Weight of Solution. Grms.	TiO ₂ found (II.). Grm.	TiO ₂ by Standard. Grm.	Error. Grm.
(40)	10.4910	0.0624	0.0618	0.0006 +
(41)	10.5970	0.0623	0.0624	0.0001 -
(42)	20.9520	0.1373	0.1343	0.0030 +
(43)	21.1750	0.1385	0.1357	0.0028 +
(44)	21.0250	0.1369	0.1347	0.0022 +
(45)	20.8740	0.1357	0.1338	0.0019 +
(46)	21.0570	0.1383	0.1349	0.0034 +

In experiments (40) and (41), in which comparatively small amounts of titanium were employed, the separation from alumina was reasonably good after the second precipitation, but in (42) to (46) the larger quantities of titanic oxide still retained notable amounts of alumina. The precipitates of (45) and (46) were therefore treated again just as before, to determine the effect of a third precipitation.

	Weight of Solution. Grms.	TiO ₂ found (III.). Grm.	TiO ₂ by Standard, Grm.	Error. Grm.
(45)	20.8740	0.1347	0.1338	0.0009 +
(46)	21.0570	0.1360	0.1349	0.0011 +

Three precipitations left the titanic oxide of these experiments nearly free from alumina, but three such treatments involve a good deal of labour, and, moreover, it is evident that the precipitate still holds with tenacity traces of alumina. The experiment of attempting to remove residual alumina after a single precipitation, by treating the product of fusion of the precipitate in sodic carbonate with boiling water, filtering, igniting the residue, again fusing with a little sodic carbonate, and proceeding from this point to dissolve in sulphuric acid and precipitate once more as before, was therefore tried, and the result is given in the record of (47) to (50).

	Weight of Solution. Grms.	TiO ₂ found. Grm.	TiO ₂ by Standard. Grm.	Error. Grm.
(47)	20.8640	0.1329	0.1337	0.0008 -
(48)	21.1100	0.1345	0.1354	0.0009 -
(49)	20.9100	0.1332	0.1340	0.0008 -
(50)	21.0020	0.1348	0.1346	0.0002 +

This mode of treatment appears to remove the last traces of alumina, and yields a reasonably good separation.

It appears, therefore, to recapitulate, that for the separation of titanium and aluminum either of the processes set forth in the preceding work may serve. The first, however,—which is, in brief, the treatment of the solution containing salts of the elements in question with a mixture of microcosmic salt and formic acid, in the proportion of two to three by weight, together with enough ammoniac formate to take up the stronger acids, fusing the precipitate in sodic carbonate, extracting with water, fusing the residue in a small amount of sodic carbonate, dissolving in sulphuric acid, and precipitating by ammonia with the subsequent addition of acetic acid, and boiling,—though probably fairly accurate, is, on account of the nature of the precipitated phosphate, not comparable with the second method in point of convenience. The latter process, which involves many different manipulations,—the introduction into the solution of titanium and aluminum of enough acetic acid to make from 7 to 11 per cent by volume of the absolute acid, together with sufficient sodic acetate to fix all of the stronger acids in sodium salts, boiling, filtering, and washing with acetic acid of 7 per cent strength, fusing the ignited precipitate in sodic carbonate, extracting with boiling water, again fusing the residue with a little sodic carbonate, dissolving in strong sulphuric acid and pouring this solution into water, neutralising with ammonia, re-dissolving the precipitate in a known amount of sulphuric acid, and precipitating finally by boiling with acetic acid and sodic acetate as at first,—and appears in the description to be long and tedious, may in reality be carried out with ease and rapidity, the operations being generally short and not of a difficult nature.

In most cases in which titanium is to be separated from aluminum it is necessary to effect the removal of iron as well. Some experiments looking to the separation of titanium and iron, by boiling the acetates in presence of a large excess of acetic acid, were unsuccessful; for, though an excess of acetic acid amounting to 11 per cent of absolute acid in the solution is enough to prevent the deposition of a basic ferric acetate, it appears, unexpectedly, that in presence of ferric acetate in solution the titanium shows a very marked tendency to remain dissolved. Thus, an amount of iron alum the equivalent of 0.2 gm. of ferric oxide, together with 10 grms. of sodic acetate and 17 per cent of absolute acetic acid, in a total volume of 400 c.m.³, held 0.06 gm. of titanic oxide completely in solution during boiling prolonged a quarter of an hour. In an experiment the counterpart of this, excepting only the addition of sodic acetate, the titanium began to deposit at once on boiling; and Streit and Franz,* in proposing the ebullition of the sulphates in presence of a large excess of acetic acid as a means of procuring titanic oxide free from iron, claim a complete precipitation under these conditions. The behaviour of the sulphates of titanium and zirconium when in solution together appears to be analogous to this action of the acetates of iron and titanium, and iron in the ferric condition is generally supposed to influence somewhat the precipitation of titanium from the solution of the sulphates.

When iron and titanium appear together in solution, and are to be separated, the choice lies between Stromeier's application of Chancel's hyposulphite method,† which yields milky filtrates,—always undesirable,—and that process which involves the precipitation of iron by ammoniac sulphide in presence of ammoniac tartrate to hold

* *Jour. f. Prakt. Chem.*, cviii., 65.

† *Ann. Chem. Pharm.*, cxiii., 127.

up the hydrates which would be precipitated in its absence. This latter method has been regarded as an undesirable one chiefly on account of the inconvenience involved in the evaporation of the filtrate from the ferrous sulphide and the ignition of the residue to remove the tartaric acid, and so to permit the recovery of the bases. The difficulty in question may be obviated, however, by destroying the tartaric acid by potassic permanganate added gradually to the hot solution containing enough free sulphuric acid to leave some excess after the conversion of all the permanganate. The oxidation of tartaric acid by potassic permanganate does not, as is well known, yield carbonic acid and water alone, but gives rise also to a considerable quantity of formic acid as an intermediate product. When the permanganate begins to act upon the formic acid, the oxidation, going more slowly, results in the deposition of a brown manganic hydrate, which, if any tartaric acid remains in solution, re-dissolves quite rapidly, and, in presence of formic acid as the only reducing agent, more slowly. When, therefore, manganic hydrate is abundantly precipitated in the boiling solution, and does not perceptibly dissolve, it is quite certain that the conversion of the tartaric acid to formic acid—which is all that is needed in this case—has been accomplished; but for the sake of greater security the addition of permanganate may be continued until its colour shows in the solution. It is well, however, to make use in this process of a known amount of tartaric acid,—experience has shown that an amount equal to three times the weight of the oxides to be held in solution is sufficient, unless ammonia be used in enormous excess and the boiling prolonged,—and to employ for its destruction two and a half times its own weight of potassic permanganate, this quantity being more than enough to carry the oxidation to the final products, providing there were no deposition of manganic hydrate. The manganese thus introduced into the solution may be removed by two acetate precipitations, which, if alumina is to be separated, must be made at any rate, even if no manganese be present.

To separate titanium, aluminum, and iron, therefore, I find it most convenient to precipitate the iron by passing hydric sulphide into the faintly ammoniacal solution of the oxides in ammoniac tartrate, taking care that the solution is still ammoniacal just before filtering; to destroy the tartaric acid in the filtrate, after acidifying and boiling off the hydric sulphide by means of potassic permanganate in the manner just described, re-dissolving residual manganic hydrate by the addition of a little ammoniac bisulphite, and boiling off the excess of sulphurous acid; and to separate the titanium and aluminum by the acetate process.

A single point in the analysis of silicates may be worthy of note in this connection. If phosphoric acid be present, as is often the case, the separation of titanium from silica by the action of cold water upon the product of fusion in sodic or potassic bisulphate is liable to uncertainty, on account of the formation of the insoluble titanic phosphate which remains partly with the silica and in part clouds the filtrate. The siliceous residue should, therefore, be treated with sulphuric and hydrofluoric acids to recover titanium which may be with the silica. It is better in most cases to effect the decomposition of a silicate by means of one of the fluoride methods, or by fusion in an alkaline carbonate, the melt in the latter case being acidified with hydrochloric acid, and the residue, after evaporation and filtration, worked over with sulphuric and hydrofluoric acids for the recovery of that portion of the titanium which remains insoluble after the evaporation.

Double Bromides of Gold and Phosphorus and a Chlorobromide.—L. Lindet.—The author has obtained the compounds $\text{Au}_2\text{Br}_3\text{PBr}_3$ and $\text{Au}_2\text{Br}_3\text{PBr}_5$. He has also studied the double chlorobromides of gold and phosphorus, but has obtained only one $\text{Au}_2\text{Br}_3\text{PCl}_3$ as a definite compound.—*Comptes Rendus*, vol. ci., No. 2.

CORRESPONDENCE.

FILTERS.

To the Editor of the Chemical News.

SIR,—The following fact with regard to the action of a filter may be of interest to your readers in connection with the important paper by Dr. Percy Frankland (*CHEM. NEWS*, vol. li., pp. 27, 40).

A few days ago I received for analysis some samples of water used by a family of which one of the members was ill with typhoid fever. One of the samples was from the house pump direct, and another was from the same source but filtered through a charcoal filter. On analysis the filtered water, while identical with the other in mineral qualities, showed a considerable increase of albumenoid ammonia over that contained in the unfiltered water. With solution of permanganate the filtered water decolourised five times as much as the unfiltered, and even then was not tinted. On the addition of pure sugar the filtered water quickly became very turbid, while the unfiltered water remained practically unchanged.

After my report was sent in I learned that the filter had been in use for more than a year, and that the owner had found the water so bad in a locality where he was last year that "he had to filter the water for his bath."—I am, &c.,

THOMAS FARRINGTON, M.A., F.C.S.,
Analyst to the County Cork Agricultural Society.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 2, July 13, 1885.

The Magnesia Industry.—Th. Schlöesing.—The author, some years ago, described the method pursued for extracting magnesium hydrate from sea-water. He now speaks of its uses as the primary material for the manufacture of refractory products, infusible bricks, &c. It is necessary, however, to heat the magnesium hydrate to whiteness, so that it may not shrink on exposure to high temperatures. This strongly-ignited magnesia is worked up with another portion of magnesia which has been heated merely to redness, and which is then agglomerated by pressure. Four parts of the magnesia which has been heated to whiteness are mixed with one part heated to redness only, and the mixture is then submitted to a pressure of 10,000 kilos. per square decimetre.

Absorption Spectra of Certain Colouring-Matters. Ch. Girard and M. Pabst.—See p. 54.

Electric Resistance of Copper at the Temperature of 200° Below Zero, and on the Insulating Power of Liquid Oxygen and Nitrogen.—S. Wroblewski.—Liquid oxygen and nitrogen rank among the most perfect insulators. The resistance of copper decreases much more rapidly than the absolute temperature, and approaches zero at a temperature not very remote from that obtained by evaporating liquid nitrogen in a vacuum.

Method of Producing the Alkaline Earthy Manganites.—G. Rousseau.—The alkaline earthy chloride, rendered strongly alkaline by a previous addition of the corresponding base, is kept in fusion in a platinum crucible. As soon as the temperature reaches an orange-red a quantity of manganese chloride is introduced, equivalent to half the base added. A precipitate of manganous

oxide is thus obtained in a fine state of division. It is rapidly peroxidised in contact with the air and the free base, and forms a crown of crystals of alkaline-earthly manganite.

New Method of Assaying Tanniferous Matters.—F. Jean.—No particulars are given.

Justus Liebig's Annalen der Chemie,
Vol. ccxxix., Parts 1 and 2.

Communications from the Physico-chemical Laboratory of the University of Leipzig.—These communications contain a memoir by R. Behrend concerning experiments on the synthesis of bodies of the uric acid series. The author's principal results are that:—

1. Acetacetic ether and urea combine to β -uramido-crotonic ether.
2. This ether yields on saponification the alkali salt of methyluracil.
3. Phosphorus pentachloride converts methyl-uracil into the trichlor-derivative of a hypothetical radicle, which is distinguished from picolin by nitrogen being substituted for a methine group.
4. Nitric acid oxidises methyl-uracil to nitro-uracil-carbonic acid.
5. The latter loses carbonic acid, and passes into nitro-uracil.
6. Nitro-uracil is reduced to amido-uracil by tin and hydrochloric acid.
7. Amido-uracil on treatment with strong acids yields oxy-uracil, an isomer of barbituric acid.
8. Amido-uracil combines with cyanic acid to form hydroxy-xanthine.

Constitution of Succinylsuccinic Ether.—H. Ebert.—Not susceptible of useful abstraction.

The Synthesis of a Tetra-basic Acid and an Isomer of Aconitic Acid.—G. Schacherl.—The new compound in question is propargylen-tetra-carbonic-ethyl-ether, a faintly yellowish liquid, heavier than water, and isomeric with Conrad and Guthzeits's dicarboxyl-glutaconic-ester. The isomer of aconitic acid is the pseudo-aconitic acid. It is distinct from natural aconitic acid and from trimethylen-tricarboxylic acid.

On Retene.—E. Bamberger and S. C. Hooker.—A very voluminous paper which does not admit of useful abstraction.

Anomalies in the Boiling-points of Chlorinised Aceto-nitriles and their Derivatives.—H. Bauer.—Whilst as a rule the substitution of chlorine or oxygen for hydrogen decidedly reduces the volatility of organic compounds, a series of compounds are known in which this substitution produces either a very trifling effect or one in the opposite direction. This is especially the case in cyanogen compounds, the volatility of which is generally increased by the introduction of electro-negative radicles. The nitriles which the author here examines display sometimes considerable, and sometimes small, changes of their boiling-points when oxygen in combination with an alcohol radicle is substituted for chlorine.

Note to Paul Volkmann's Remarks.—R. Schiff.—A discussion on the "constants of capillarity." (See vol. ccxxviii., p. 96).

Communications from the Laboratory of the Royal Academy of Sciences at Munich.—These comprise a paper on the nitration of cinnamic derivatives, by P. Friedlaender; a memoir by P. Friedlaender and J. Mahly on the nitration of paranitro-cinnamic acid; and a memoir by P. Friedlaender and M. Lazarus on the nitration of meta-nitro-cinnamic acid, ortho-nitro-cinnamic acid, ortho-amido-cinnamic acid, carbostyryl and para-amido-cinnamic acid.

Fyridin-tricarboxylic Acid.—C. Böttinger.—Referring to a paper by R. Voigt (vol. ccxxviii., p. 29) the author maintains that his pyridin-tricarboxylic acid obtained by

oxidising uvitonic acid by potassium permanganate is pure and finely crystallised.

Bulletin de la Société Chimique de Paris.
Vol. xliii., No. 12, June 20, 1885.

The Action of Carbonic Acid upon Potassium Chloride in Presence of the Carbonates of Different Amines.—A. Müller.—The author has made two series of experiments: in the one the amine carbonate was in a solution sufficiently dilute to keep the products of the reaction dissolved. In the other this carbonate was so concentrated that almost the whole of the potassium chloride and bicarbonate was precipitated. In the first series trimethylamine forms a striking exception to the other amines examined; its coefficient of reaction, instead of being 0.50, like that of the other amines examined, is equal to 0.11 under similar conditions; on the contrary, its speed of carbonation is the greatest, and the resulting liquid in the experiments made with this amine is the most highly carbonated of the whole series. In the second series dimethylamine is the one which has the greatest coefficient of reaction, whilst the solubility of the potassium salts is the smallest.

Journal de Pharmacie et de Chemie.
Series 5, Vol. xii., No. 1, July 1, 1885.

Addition-Product obtained by the Action of Bromine on Phosphorus Trifluoride.—H. Moissan.—Already noticed.

Platin-Iridium for Standard Kilogrammes.—M. Stas.—Messrs. Johnson and Matthey, on June 17th of this year, succeeded in producing an ingot of platin-iridium from which they forged a round bar 200 c.m. long and 44 m.m. in diameter. The discs cut from this bar are of a splendid whiteness and lustre, and physically homogeneous. The material used was absolutely free from ruthenium. Each cylinder has received a pressure of 4,320,000 kilos., or 720,000 kilos. more than the International Commission of the Metre required. The alloy contains not a trace of free iridium. The filings, when cleaned, contain $\frac{1}{1000000}$ of iron, and the turnings $\frac{1}{1000000}$, or in round numbers $\frac{1}{1000000}$. Half of this quantity is introduced during working, as the materials contain only $\frac{1}{1000000}$.

Cosmos les Mondes.
No. 22, June 29, 1885.

Measurement of the Intensity of the Sun's Rays.—M. Morize of Rio Janeiro has applied selenium to the measurement of the solar rays at different hours of the day. It consists of a cylinder composed of discs of copper separated by leaves of mica and connected electrically at their edges by selenium. It is insulated on a glass support and is fixed so that its axis is parallel to that of the earth. Under these conditions the rays of the sun strike it approximately at the same angle throughout the day. It is interposed in a circuit of constant force, along with a galvanometer, the variations of which show those of the intensity of the solar rays.

Bulletin de la Société Encouragement pour l'Industrie Nationale. 3rd Series, vol xii., No. 137. May, 1885.

This issue contains no chemical matter.

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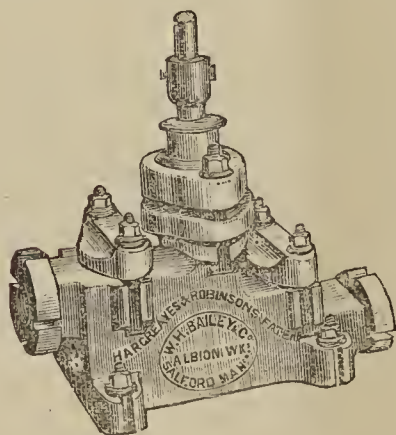
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PATENTS, DESIGNS, & TRADE MARKS ACT, 1883.

In the matter of Letters Patent granted to FREDERICK SETTLE BARFF, of St. John's Wood, Professor of Chemistry, for "A new compound to be employed in the preservation of organic substances," dated 25th March, 1881, No. 1332.

NOTICE IS HEREBY GIVEN that the said Frederick Settle Barff has applied for leave to amend the above Specification.

A copy of the Specification as proposed to be amended can be inspected at the Patent Office, and full particulars of the proposed amendment were advertised in the Official Journal of the Patent Office issued on the 31st July, 1885.

Any person or persons intending to oppose the said application must leave particulars in writing of his or their objections thereto at the Patent Office, 25, Southampton Buildings, London, W.C., within one calendar month from the date hereof.

Dated this 31st day of July, 1885.

(Signed)

H. READER LACK,
Comptroller General.

J. HENRY JOHNSON,
47, Lincoln's Inn Fields, London,
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THE CHEMICAL NEWS.

VOL. LII. No. 1342.

THE BIOLOGICAL EXAMINATION OF WATER.

By C. J. H. WARDEN, Surg. H.M.'s Bengal Army,
Professor of Chemistry, Calcutta Medical College.

(Continued from p. 68.)

IV. Analytical Process.

IN Prof. Koch's earlier method for the bacteriological examination of water, the specimen was mixed with the liquefied nutrient gelatin contained in a test-tube. On the gelatin solidifying each micro-organism was fixed, and developed into a colony, and from the appearance presented by the tube after the lapse of a few days a rough idea was formed of the number of germs present. But this method, though perhaps occasionally useful, lacks precision: the number of colonies of micro-organisms cannot be estimated, and the description of the appearance of the tube must be left to the judgment of the operator; the results, therefore, have no quantitative value, and are not comparable. By the employment of glass plates, on the other hand, to receive the liquefied gelatin after admixture with the water, the development of the bacterial colonies may be watched, the morphological characters of the organisms ascertained, other culture media may be inoculated from individual colonies, and lastly, the number of germs present in a given volume of water may be estimated; the results, therefore, arrived at by different operators are strictly comparable.

The first step before admixture of a sample of water with the nutrient gelatin is to ascertain approximately the number of micro-organisms present, for on the number depends the volume of water which will have to be employed for the analytical process. If the sample be contained in an Erlenmeyer's flask, the caoutchouc cap is removed, the cotton-plug singed, and the mouth of the flask heated by a Bunsen or other flame. The plug is then withdrawn with a twisting movement, the flask being held slanting: with a sterilised glass rod or pipette a drop of water is removed, placed on a clean cover-glass, and allowed to dry under a bell-jar. When the water has evaporated, one corner of the cover-glass is held by a pair of forceps, the side containing the residuum being upwards, and the glass rapidly drawn *three times* with a downward motion through a colourless Bunsen, or large spirit-flame. The cover-glass, still held by the forceps, is then flooded with methyl-blue solution, which is allowed to act for about three minutes. The dye is then washed off by a gentle stream of water, and the cover-glass mounted on a slide with a drop of water, and examined with a $\frac{1}{12}$ oil immersion system. If it be thought desirable to preserve the specimen, the cover-glass should be taken off from the slide, oil removed from the back, and the glass allowed to dry by exposure to air, and ultimately mounted in Canada balsam dissolved in xylol. Care must be taken not to employ heat during mounting, else the bacilli will be decolourised.

On microscopic examination of a cover-glass preparation, if one bacillus be detected in each field, one drop of the water will contain many hundred, and less than one cubic centimetre will have to be taken for mixing with the gelatin. On the other hand, should several "fields" have been examined without detecting a bacillus, then 1 c.c. of the water should be taken. It is difficult, however, to lay down specific rules regarding the exact volume of water to be employed. It is better to take too little than too much, because in the latter case the colonies which develop in the gelatin are so close together that they coalesce, and the examination then becomes difficult or impracticable.

A drop of the water should also be examined in a cupped slide in order to ascertain the motility of the organisms. For this purpose the edge round the depression in a cupped slide is painted with vaseline, and a drop of water placed in the centre of a cover-glass, which is then inverted, and fixed over the hollow by the layer of vaseline. The preparation is then examined with a $\frac{1}{12}$ oil system, and a diaphragm with a very small aperture before the sub-stage illuminating apparatus. In the periphery of the drop the movement of the organisms will be best visible.

Examination of the stained cover-glass preparation and of a drop of the water mounted in a cupped slide will lead to the detection of—

Bacilli movable and stationary, of different size, shape, and thickness, single, in groups, or chains.
Micrococci, single, in chains, or zooglæa form.
Vibrios.
Spirilla.
Algæ, &c.
Amorphous and granular detritus.
Crystalline bodies.

Care must be taken not to confound the Brownian movement of inorganic particles for the motion of micrococci; and the distinction of bacteria from inorganic substances is also a point which needs attention. Dr. Sternberg* remarks:—"The smallest forms of bacteria may be confounded with various matters, with organic particles, molecular granules, fat globules, &c. These productions, which are found in considerable quantity in the liquids or in the tissues of animal or vegetable origin, often resemble so closely in form, size, and grouping the spherical bacteria, that it is absolutely impossible to guard one's-self against confusion unless the most minute precautions are taken in making the observations (Cohn). The detritus, the amorphous powder, of precipitated molecules of inorganic substances, even when they exhibit the Brownian movement, are easily enough distinguished from micrococci by optical signs, their angular form, their less refractive power, and finally by their reaction with certain chemical agents; above all, if they are mineral substances, crystalline bodies, &c. It will not be the same with molecular granules of organic nature. They have a common character, their rounded form, their notable refractive power, movements. Nevertheless, their form is less regular, more angular, their colour variable, their refractive power always less. In doubtful cases, Tiegel has given a method which enables us to distinguish them from micrococci. It consists in warming the glass slide which supports the corpuscles under examination; if they are 'coccos' they are seen to move in a manifest manner. This does not occur in the case of molecular granules.

"Hiller, who has paid especial attention to the means of recognising bacteria, divides them into two groups:—

"A. The optical signs: comprising—(1) The characteristic vegetable form, rods, leptothrix; this he recognises as of little use, as in this case there is no doubt. (2) The characteristic movements of the monads. (3) The mode of growth and of multiplication. (4) The mode of junction of the granules.

"B. The chemical signs:—(1) False zooglæa become softened and diffuent under the action of liq. potassæ, and are coagulated by direct application of alcohol. (2) In sections of tissues after an hour of maceration in liq. potassæ, diluted one-tenth, the monads are coloured brown by iodine, while fat granules are not.

"But, in truth, the method of cultivation extolled by Cohn and Wolff is the best means of distinguishing bacteria. The distinction of pseudo-bacteria," says the first of these authors, "from veritable globular bacteria is a problem which our microscopists cannot resolve, in any case with desirable certainty. It is only by a study of their mode of

* "Bacteria," by Sternberg and Magnin.

development that this distinction can be made. *The globules which divide and develop in form of chains are organised beings; when this does not occur, we are dealing with pseudo-bacteria.* This, however, is not exactly the opinion of Nägeli, who seems to consider movement as the surest distinctive characteristic. 'There are,' he says, 'but three distinctive signs which enable us to recognise with some certainty that granules under observation are organisms, —spontaneous movement, multiplication, and equality of dimensions, united with regularity of form.'

"The most certain sign is movement in a straight or curved line—a movement which inorganic granules never present. One should take care not to be deceived by movements which are caused by currents in the liquid under observation. Nor should one allow himself to be deceived by the tremulous motion, called molecular movement, in which the granules do not really change their position. These movements are seen in most cells, and even in those of the Schizomycetes, and inorganic bodies themselves present it.

"Multiplication is a character less important than movement. When among granules some are found united in pairs, it may be supposed with probability that division and multiplication are taking place. When rods are bent at an angle, one may predict their division into two parts.

"Finally, as to size and form. Granules of different size and of a more or less irregular form ought not to be considered as belonging to the group of segmented fungi; if, on the contrary, the granules offer dimensions perfectly equal, and a spherical or oval form, the distinction is more uncertain: they may belong to the schizomycetes or be of inorganic nature."

If 1 or 0.5 of a c.c. of the water be employed for the analytical process, the volume can be measured from a divided pipette. If smaller volumes be used, it is better to dilute the sample with sterilised distilled water, so that 1 c.c. of the mixture shall represent the requisite volume of water, than attempt to deliver from a graduated pipette one- or two-tenths of a c.c.

The volume of water to be used is now to be mixed with the gelatin. For this purpose the contents of a test-tube containing meat peptone gelatin is liquefied either by cautious direct application of a flame, first to the upper and then to the lower layer of gelatin, care being taken to avoid boiling, which would cause the formation of bubbles; or, preferably, by immersing the lower part of a tube in water heated to 30° C. After the tube has stood for some minutes, ascertain, by inclining it, whether the whole of the gelatin has been liquefied or not. This precaution should always be taken, more especially, perhaps, when direct application of a flame has been used to liquefy the gelatin, otherwise a plug of solid gelatin may remain in the centre. If the whole of the gelatin has been liquefied, wipe the tube, twist the cotton-plug round without withdrawing it,—to break down any adhesions it may have contracted to the glass, by the sides having been accidentally moistened with gelatin,—and pass the upper part of the tube through a flame two or three times so as to singe the plug, and so destroy any germs which may have been deposited upon it or on the lip of the tube. Allow the tube to stand for a few minutes to cool, then, holding it in the left hand in a slanting direction, remove the plug with a twisting movement, and place it between the first and second fingers of the same hand, and allow the water from the sterilised pipette to flow down the side; immediately replace the plug, and move the tube to and fro several times in order to thoroughly mix the contents.

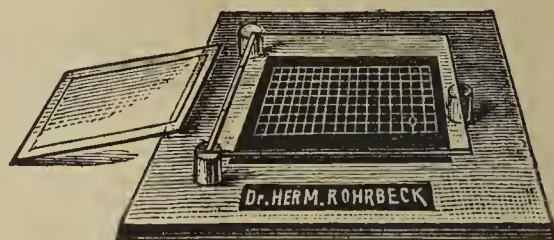
The gelatin water mixture is then poured on the centre of a sterilised glass plate supported on the levelling apparatus (Fig. 7), and with a sterilised glass rod evenly spread so as to form a square of about 9×9 c.m., thus leaving an uncoated margin round the plate. This operation must be rapidly performed, as the gelatin, owing to the low temperature, sets quickly. Care must be taken to prevent the formation of air-bubbles. The coated plate is covered with a bell-jar (E, Fig. 7), and after the lapse of about

four minutes placed upon a glass bench (Fig. 4), on which has been previously laid a slip of filter-paper, giving particulars of the nature of the experiment, and the plate supported on the bench introduced into a moist chamber, which is immediately closed. A second plate and bench may then be placed over the first, and so on until the chamber is filled.

The volume of liquefied gelatin which is spread over a plate of the dimensions prescribed should not be less than 10 or 11 c.c.; if the layer be too thin it dries rapidly, and the growth of the micro-organisms is retarded; an unduly thick stratum also acts prejudicially.

The moist chamber should be kept in a moderately cool room; a temperature of 60° to 65° F. is the most suitable. A very low temperature retards growth, or may even prevent the development of colonies. After the lapse of 24 to 30 hours, depending upon the temperature, the plates should be examined. The colonies at first appear as minute whitish spots, which gradually increase in size. Certain colonies will liquefy the gelatin, and the liquefied portions will be either colourless or present a greenish yellow fluorescence; or more rarely a violet colour may be produced. Others will remain solid. After about 72 hours, when the colonies have reached a sufficient size so as to be visible without difficulty to the naked eye, their enumeration should be made.

FIG. 13.



If the colonies be few in number they can be at once counted, but when a large number have developed the contrivance shown in Fig. 13 is useful. The apparatus consists of a wooden frame, on which is fixed a glass plate ruled by horizontal and vertical lines into squares of 1 centimetre, some of the squares being again subdivided. Behind the plate is placed a piece of dull black cloth or paper. The gelatin plate on which the colonies are to be counted is placed on the ruled plate, and the number of colonies which fall in one line of vertical and one line of horizontal squares counted, and the figures so obtained multiplied, the result representing approximately the number of germs originally present in the volume of water employed for the analytical process. Unless the colonies are very evenly distributed over the surface of the plate it is better to take the mean number of colonies found in two or three lines of horizontal and the same number of vertical line squares, and to multiply the means together. It frequently happens that a colony falls on a line, in which case some such rule as the following should be adopted:—Colonies falling on a line to the left, in a vertical square, are to be counted, those to the right excluded. A similar rule is also applicable to the lines bounding the horizontal squares.

An efficient substitute for the apparatus described as Fig. 13 is made by ruling on a sheet of dull black paper pasted on cardboard, a square 10×10 c.m. divided into 100 squares of 1 cubic metre each, a few of the squares being subdivided as is shown in Fig. 14.

After the total number of colonies has been estimated, the enumeration of those which have liquefied the gelatin should be made. The results may be recorded in the following manner:—

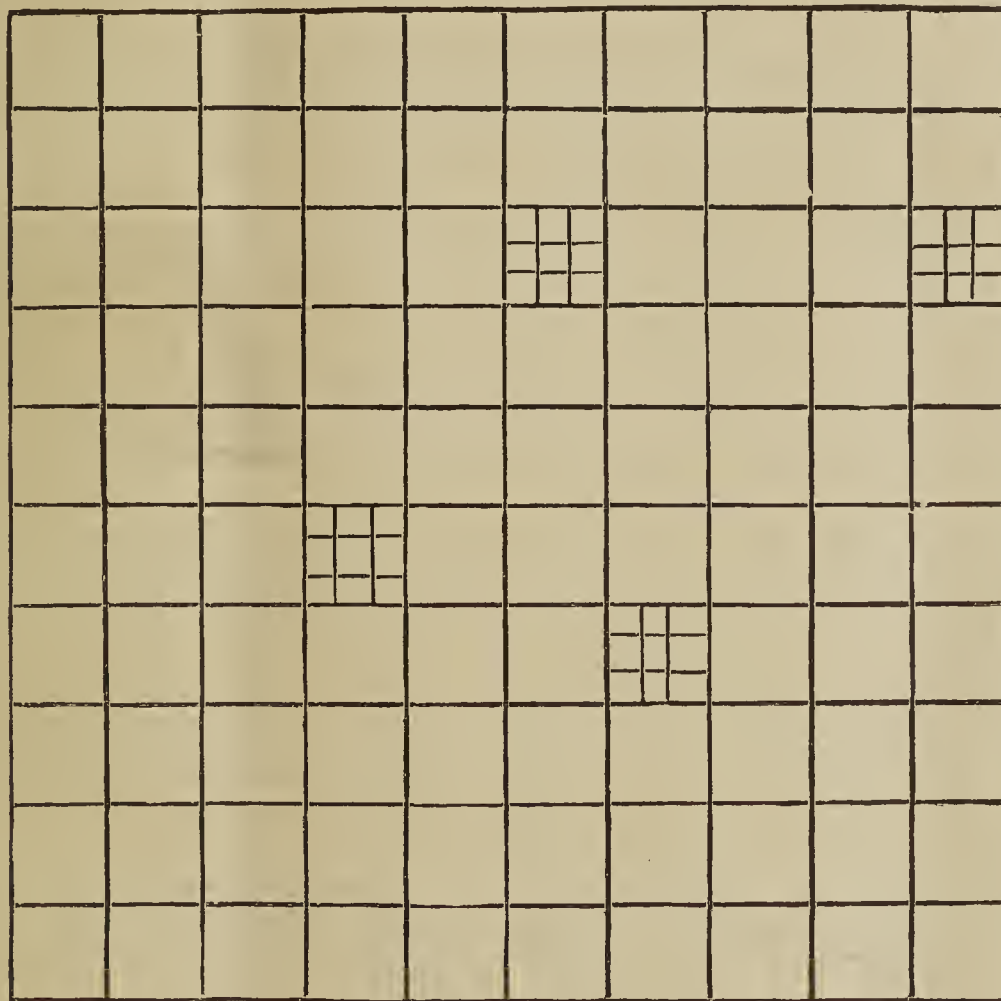
One cubic centimetre of the water contained —
Colonies of which —
Liquefied the gelatin —

A record should also be kept of any peculiar appearance, colour, or odour, &c., of the colonies.

Although mere enumeration of the colonies developed on a plate affords valuable indications, yet the maximum amount of information which the method can yield is by no means exhausted. Bacteria are normal constituents of natural waters; and the information which is of importance is not only the number present above the normal, but also the kind. A water teeming with micro-organisms might be drunk with impunity; but if a water contained micro-organisms much below the normal in number, but which could be identified as being similar to the organisms found—for instance, in the cholera process the use of such water would certainly be attended with danger; for leaving aside the question whether the cholera bacillus is or is not the cause of the disease, the fact remains that the organism described as the Cholera Bacillus by Dr. Koch occurs only in Asiatic cholera, and its detection consequently in water is *prima facie* evidence of contamination with Cholera

This method, while permitting the morphological characters of the organism to be viewed, also shows its disposition in the colony. Or, while the plate is on the microscope stage, and a particular colony in the field, a portion of the colony is removed by a platinum wire, and rubbed over a cover-glass, which is then heated and stained in the usual way. This procedure is especially useful when the colonies are close together, and it is desirable to examine the contents of one only. The platinum wire should be moderately thick, and mounted in a glass rod, the wire at about one line from the free end being bent nearly at right angles. The wire is heated red-hot, allowed to cool, and the glass rod held between the thumb and fore finger of the right hand, the little finger resting on the side of the stage. The bent point of the wire is now brought into contact with the centre of the object-lens, the eye applied to the eye-piece, and the point of the wire carefully depressed

FIG. 14. (ORIGINAL SIZE.)



Dejeña. It is therefore of moment that the examination of a water should not be considered as completed with the mere enumeration of the bacteria.

After the first appearance of the development of colonies a plate should be microscopically examined at regular intervals, and the general outline, refractive power, and mode of growth of the colonies watched. For this purpose the plate is placed on the stage, and examined with a low power,—Zeiss's A A system, with No. 3 eye-piece magnifying 71 diameters, being sufficient, a small diaphragm being fixed below the sub-stage illuminating apparatus. The morphological characters of the organisms which form the colonies should also be examined; and this may be accomplished in one of two ways:—A cover glass may be pressed over a colony, removed with a pair of forceps, passed three times through a flame, then stained in the manner already described, and examined, mounted in a drop of water, with a $1/12$ oil immersion system.

until it appears over the colony, when it is still further depressed so as to be engaged in the colony. The eye is then closed, the point of the wire raised, and the trace of the colony removed, rubbed over a cover-glass, which is then heated and stained. The colony which has been operated upon is then re-examined, to ascertain whether the operation has been properly performed or not. If a large amount of gelatin be removed with a colony there is some difficulty in fixing the organism on the cover-glass. After staining, and on washing the cover-glass, nearly the whole of the stained colony will be washed away. This is best obviated by placing a small drop of bouillon on the cover-glass, and then mixing the portion of removed colony with it, and spreading the mixture over the glass. After drying, the cover-glass is heated and stained as usual. Or, after staining, the cover-glass, with the dye solution still on it, is inverted on a slide, and the dye liquid soaked up with blotting-paper: a few drops of water are then

placed near one of the edges of the cover-glass, and removed from the opposite edge by blotting-paper, and this is repeated until the superfluous dye solution has been removed.

The mode of development in bouillon of an organism removed from a colony may also be necessary as a means of diagnosis. The bouillon is inoculated within the organism by touching a colony with a sterilised platinum wire, and then bringing it into contact with a drop of bouillon on a cover-glass, which is then inverted over a cupped slide in the manner already described. The cupped slide may be kept at a temperature of from 25° to 30° C., and examined at intervals of about twelve hours with a 1/12 oil immersion system, and a very small diaphragm below the sub-stage illuminating apparatus. The motility, formation of spores, development of spirilla, and mode of division of the micro-organism will by this means be ascertained.

The mode of growth of an organism on a sterilised potato also affords useful information. Certain organisms grow well at ordinary temperatures, others only develop at a high temperature. Some form a coloured layer on the surface of the potato; in others, at a high temperature, a large development of spores occur. In order to inoculate a potato, a sterilised potato, prepared in the manner already described, is held between the fingers of the left hand,—previously washed with corrosive sublimate solution,—and divided by a sterilised knife. A rather large amount of the colony is then placed upon the centre of the potato, and with a sterilised scalpel spread over the surface, leaving a free margin round the potato. The inoculated potato is then placed in a moist chamber, and kept at either an ordinary or a high temperature, as the case may be. Fractional cultivation on a potato is performed by transferring a small fragment of the mixture of potato pulp and colony from the surface of the first potato, and placing it upon a second, over which it is spread; from the second potato a portion is then removed to a third. For each potato divided, and for each portion of inoculated potato pulp transferred, a freshly sterilised knife and scalpel must be employed.

The mode of growth of an organism in a test-tube in gelatin is also of importance. A test-tube containing sterilised gelatin is inoculated in the following manner:—The test-tube containing solid gelatin is inverted, the cotton plug removed, and the substance with which the gelatin is to be inoculated touched with a sterilised platinum wire mounted in a handle, which is then pushed through the gelatin, removed, and the tube re-plugged.

In the ordinary course of an analysis it is by no means rare to find on the surface of the gelatin plate a few growths of micro-organisms which have been derived from the air, and which may consist of moulds, or colonies of bacteria, and sarcina, &c. It will be observed that all these growths have sprung from the *surface*, and not from the *interior* of the gelatin. It is necessary, however, that the analyst should be familiar with these organisms which occur in air, and for this purpose—before commencing to examine a sample of water—to make a few blank experiments in the following manner:—Prepare one or more plates without admixture of water with the gelatin, and keep the plates in a moist chamber. In a second experiment expose one or more plates coated with gelatin to the air, for varying periods. If no development occurs on the plates of the first experiment it is evidence that the reagent and apparatus have been properly sterilised. The growths on the plates in the second series will have been derived from the air.

(To be continued.)

Speed of Saponification.—Z. Th. Reicher.—The author's experiments prove that for every compound ether there can be determined a value characteristic of the speed of its saponification—the so-called "speed-constant,"—*Justus Liebig's Annalen der Chemie*.

THE SPECTRAL STUDY OF BODIES RENDERED PHOSPHORESCENT BY THE ACTION OF LIGHT OR BY ELECTRIC DISCHARGES.

By M. E. BECQUEREL.

THE analysis of the phosphorescent light emitted by certain substances may sometimes, like that of the light derived from the irradiation of incandescent vapours, be utilised in chemical analysis: I have already shown how in this respect we can make use of the phosphoscope in case of solid bodies, such as alumina, the compounds of uranium, and hydrocarbons like anthracene, and analyse the light emitted by bodies rendered active in this apparatus.

When substances which can present effects of this kind are in a state of solution, or even when in a solid state, the duration of the persistence of luminous impressions after the action of the exciting ray is too short to be appreciated in the phosphoscope, they give rise to phenomena of fluorescence, differing from those of phosphorescence merely by the duration of their persistence. In this case we may have recourse to a very simple procedure, consisting in illuminating the substances strongly by means of violet light concentrated by a lens, and obtained by causing the solar rays to pass through an ammoniacal solution of copper, and then to analyse by refraction the light which they emit in virtue of their proper action during the influence of the exciting rays. The rays of light emitted being in general less refrangible than the exciting rays, we may observe the phosphorescence spectrum in the least refrangible part of the image and beyond the violet region.

Another means of studying these effects of phosphorescence, the use of which I indicated as far back as 1857, consists in placing the substances in tubes, the air in which is rarefied, and causing the interior of these tubes to be traversed, by means of platinum electrodes soldered to their ends, by the discharges of an induction-coil. The highly refrangible elements of the light given by these discharges excite very greatly the phosphorescence of sensitive bodies shut up in the tubes, and permit the spectroscopic analysis of the light emanating from them. On operating thus we perceive at the same time as the light of phosphorescence that which comes from the illumination of the rarefied gases, which necessitates a knowledge of the spectrum given by these gases. In certain cases we may simply, by means of an induction-coil, excite the discharges of an electric battery very near the sensitive bodies, and analyse the light which they may emit.

On rarefying the air in the tubes by means of a mercurial pump so that the internal gaseous pressure is scarcely appreciable, the effects of phosphorescence produced on the glass of the tubes, as well as on the sensitive matters contained within them, increase, in general, in a very high proportion. I say in general, for the refrangibility of the active rays depending on the nature of the substances, these begin to become luminous at different degrees of rarefaction, the refrangibility of the elements contained in the discharges varying with this rarefaction. The luminous effects of phosphorescence produced in these conditions are the same as those which can be observed with violet solar light, or by the aid of the phosphoscope, if the duration of the luminous impressions upon the bodies submitted to experiment permits. In vacuum tubes, however, they are much more intense.

This fact, which I regarded as evident, has been demonstrated by Mr. Crookes, by means of alumina, which in tubes gives the same red lines as those which I observed by the aid of the two methods indicated above. The experiments which I have recently conducted, arranging a mercurial pump so as to obtain at pleasure in the tubes a vacuum of less than $\frac{1}{1000}$ atmosphere, and placing in these tubes well-defined compounds of uranium (double

sulphates, nitrates, &c.), fluor-spar, and other bodies, likewise afford a demonstration of the principle. When the vacuum is sufficiently made we recognise with the spectro-scope that the substances excited by the discharges give the same lines and bands as when excited by solar light. I must add that M. Lecoq de Boisbaudran, having placed at my disposal the substances with which Mr. Crookes has recently obtained in vacuum-tubes the lines and luminous bands of the compounds of yttrium, samarium, &c., I have been able to distinguish with the spectro-scope the same lines and bands on illuminating these substances by means of violet light and by the method indicated above.

When we commence to rarefy the air, and operate with a tube in constant connection with the pump, fitted at its extremities with electrodes formed of aluminium plates perpendicular to the direction of the tube, and containing different substances capable of being rendered active, if we pass into the tube the discharges of an induction apparatus, we have at first the well-known phenomena of the illumination of rarefied air. The phosphorescence of certain substances, when manifested, takes place all round the tube, whatever may be the points where these substances are placed. If we continue to exhaust we know that the dark space which exists between the bluish coating surrounding the negative pole and the luminous train extending to the positive pole augments gradually in extent, and there arrives a moment when, if the pressure is very slight, the light which appears in the tube on the electric discharges is scarcely perceptible; but the phosphorescence of the substances is very vivid, but only in the direction normal to the plate forming the negative electrode. This is one of the most interesting points resulting from the observations of different physicists, especially MM. Hittorf and Goldstein, Mr. Crookes, and M. E. Wiedemann. If we push the rarefaction of the gas beyond any limit easily observable, the luminous intensity due to the phosphorescence diminishes, for the discharges have then much difficulty in traversing the tube, and soon they do not pass at all. There are at least three phases in the phenomena observed, and the effects of phosphorescence are most brilliant in the second stage, when the illumination of the rarefied gases within the tube is scarcely apparent.

It is necessary for these experiments to be made in a tube which is always in connection with the pump; for, in general, if we pass the discharges for a few moments vapour or gases are emitted by the excited substances, or even by the electrodes: a whitish light appears in the tube, the pressure increases and the phosphorescence diminishes even to the point of ceasing almost entirely. After the pump has acted for some minutes the conditions necessary for good observations are restored.

The most probable hypothesis for explaining these effects consists in admitting that the negative pole under these conditions is the point of departure for extremely refrangible vibrations, acting powerfully to produce phosphorescence. It may nevertheless be possible that the electric discharges which are produced on the very surfaces of substances excite their molecules so as to render them phosphorescent. In this case the electricity would give rise to a molecular shock similar to that produced by light, for experiment proves that the composition of the light emitted is the same as that given by substances submitted to the action of luminous radiation.

In any case, the luminous effects obtained when the substances are thus vividly excited in these highly rarefied gas-tubes are more energetic than by any other mode of action, and give place for the following observations:—Iceland-spar, which presents so fine an orange-coloured phosphorescence, and which in the phosphoroscope or under the influence of the violet rays only offers a very brief persistence after the cessation of the exciting luminous action, gives in the tubes a luminous emission of the same shade, but the orange light persists for some

minutes. This effect has been already observed by Mr. Crookes. Alumina and leucophane likewise offer a persistence of the phosphorescent liget, but of a less duration than that of Iceland-spar. Fluor-spar does not give as marked an effect. This prolongation of the luminous emission depends doubtless on the intensity and the nature of the exciting action of the discharges upon the substances, which under the influence of rays of different refrangibility offer a permanence unequal in duration, as I have shown in making use of the phosphoroscope.

This energy of action is likewise rendered manifest by the rapid colouration of various sensitive minerals. It is known that certain specimens of colourless fluor-spar, if submitted to the action of numerous electric discharges which strike in the air very near their surfaces, take a slight violet tint, which they afterwards lose if their temperature is raised. On placing in a highly rarefied gas-tube a fragment of white fluor-spar which had formerly presented an action of this kind, after a short time this fragment, on exposure to the effluve of the negative pole, took a strong violet colour. Fragments of colourless rock-salt, which phosphoresce with a greenish yellow colour, became rapidly yellow, but their colour decreased spontaneously by degrees after a few days, turning at the same time more brownish.

It has been said that screens of very thin plates, such as mica, interposed in the tubes between the negative pole and the active substances, arrest all action upon the latter. To ascertain if this is the case, with a very phosphorescent substance and different transparent screens, I arranged in the side of a horizontal tube fitted with flat aluminium electrodes, and communicating with the mercurial pump, a tubulure in which played a stopper, to which could be suspended a very sensitive fragment of hexagonal blende. Small thin plates of quartz, rock-salt, fluor-spar, and Iceland-spar were successively interposed between the negative pole and the blende by a movement of the stopper. These different screens, though they greatly enfeebled the exciting action of the negative pole, did not arrest all action. The rock-salt manifested a permeability a little superior to that of the other matters.

It must be observed that these various bodies are themselves phosphorescent; even quartz, which emits a slightly yellowish light, and the exciting energy which emanates from the negative pole is in great part employed in rendering them luminous. We might therefore suppose that the blende receives the action of the rays emanating from the phosphorescent bodies, and that of the tube itself. But the active elements may not be the same for the blende and for these different screens, and the latter, moreover, do not arrest all exciting action. This question, very worthy of interest, requires to be studied more in detail, which I hope to undertake shortly.

Spectral analysis, based upon the phenomena of phosphorescence, and the use of which I have indicated long ago, does not seem hitherto to have come into as general use as spectral analysis by means of incandescent vapours. It does not lead to the same luminous composition for one and the same body submitted to these two modes of investigation, and besides it does not follow the same laws. While with incandescent vapours we observe the fixity of position of the lines in the spectral image of each of them, the phosphorescence spectra of solids and liquids, whilst giving lines which remain the same and at the same place under identical conditions (aluminium, fluor-spar) depend as much on the molecular state as on the chemical composition of these substances; for instance, red anhydrous alumina, and green hydrated alumina; orange Iceland-spar and green arragonite.

I must also call to mind that, with the different compounds of uranium sesquioxide there is in each image a series of bands and lines, the successive wave-lengths of which seem subject to a law which I have had occasion to point out (*Annales de Chim. et de Physique*, 4th series, vol. xxvii., p. 539; 1872).

On the other hand, different bodies are very unequally

phosphorescent, and a great number of them give continuous spectra, such as the oxides of magnesium, calcium, potassium, sodium, &c., and do not present rays; but it results from recent observations that, under the same conditions, some earths whose compounds have chemical properties nearly allied—such as yttria, samarium and holmium oxides, &c., which form the subject of the very interesting researches of M. Lecoq de Boisbaudran, give well-defined lines and luminous bands. We may therefore be permitted to hope that in the study of these combinations, as well as under other circumstances, the study of these combinations may give valuable indications—*Comptes Rendus*, vol. ci., p. 205.

ON ARBUTIN, THE BITTER PRINCIPLE OF THE COWBERRY (*VACCINIUM VITIS-IDÆA*, LIN.)

By EDO CLAASSEN.

In the *American Journal of Pharmacy* (July, 1870), I announced the existence of a bitter principle, vacciniin, in the leaves (resp. the whole plant) of the cowberry, and described its preparation from the same.

At the same time I also published several properties of it, but could not then give the matter a thorough investigation. It was not until now that I had leisure to continue the examination, and to state that the bitter principle found in that plant is not a peculiar one, but identical with another already known, viz., with arbutin, the bitter principle occurring in several other ericaceous plants, particularly in *Arbutus Uva Ursi*, Lin. In order to come to the above conclusion, a series of tests were made with the above vacciniin, and these were compared with tests made with arbutin prepared for this purpose from the leaves of *Arbutus Uva Ursi*, Lin.

Before describing these tests I may be allowed to say that there was no difference perceptible either in the form and shape of the crystals of both these bitter substances under the microscope (they form four and six sided prisms, with a dome, i. e., two planes sharpening their ends), nor in their solubility in water, alcohol, and ether, and also not in their bitter taste.

The tests made were the following:—

1. Heated on platinum foil, both melt to a clear liquid (which by and by turns black), and are entirely consumed by increased heat.
2. Heated in a glass tube, both melt at first, then turn black, and give off fumes of a peculiar smell and of acid reaction.
3. Concentrated sulphuric acid, and also hydrochloric acid, dissolve both without colour.
4. Concentrated nitric acid colours both orange, then dissolves them under evolution of red fumes, forming a reddish yellow solution, which after dilution with water is yellow.
5. The solutions of both in water are not precipitated by an alkaline copper solution, platinum chloride, corrosive sublimate, acetate and basic acetate of lead, a solution of iodine in potassium iodide, tannic and gallic acids.
6. A very dilute solution of ferric chloride colours both blue; they give then with water a blue solution.
7. A solution of phosphomolybdic acid and ammonia added to their solutions produces an intensely blue coloured liquid, which after some time turns greenish, and after a longer time the colour disappears entirely.
8. The solutions of both boiled for some time with very dilute sulphuric acid, then made alkaline by potassium hydrate, and heated with an alkaline copper solution, furnish a deposit of copper protoxide (by the glucose formed).

When preparing arbutin, it is, as I have found, of value to see that the liquid containing it when evaporated has

no acid reaction; the acid in it may be sulphuric, hydrochloric, citric, or acetic acid, because they decompose the same, as experiments made (see below sub. 1 and 2) will prove. In order to avoid this decomposition, and to collect the whole amount of the arbutin present, it is necessary, after having precipitated the decoction of the leaves by basic acetate of lead, and the filtrate by sulphuretted hydrogen, to neutralise the free acetic acid by calcium or magnesium carbonate.

1. 0.2 grm. of pure arbutin, dissolved in 20 cubic centimetres diluted (5 per cent) acetic acid, gave, after 15 minutes' boiling in a flask (meanwhile restoring from time to time the evaporated water) with an alkaline copper solution, a plainly visible reaction of glucose; after half an hour's boiling the amount of glucose had increased considerably.

2. 0.2 grm. of pure arbutin boiled in the same manner with 20 cubic centimetres of water, containing 3 per cent of citric acid, gave a fair reaction of glucose after a lapse of 10 minutes already.

Before closing this article I will mention that the fruit of the American cranberry, of which enormous quantities are brought into the market, has besides an acid a decidedly bitter taste. A small quantity of the berries was crushed under addition of water and an excess of quicklime, the mixture pressed, and the liquid filtered. The filtrate gave with ammonia and phosphomolybdic acid the above described blue colour. Crystals of arbutin, however, could not be obtained, which was probably due to the very small amount of it present in the small sample of berries. If the blue colour formed in liquids by ammonia and phosphomolybdic acid is, as is suggested in the *American Journal of Pharmacy*, characteristic for the presence of arbutin, there can be no doubt that the formation of it in the filtered juice of the American cranberries proves the presence in them of this bitter principle.—*American Journal of Pharmacy*.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,

Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from p. 65).

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
- || Following a date signifies publication discontinued.

104. JAHRESBERICHT ÜBER DIE FORTSCHRITTE DER THIER-CHEMIE. Herausgegeben von Richard Maly 1871-'83. 13 vols., 8vo. Wien, 1872-'84+
105. JOURNAL DE CHIMIE ET DE PHYSIQUE, ou Recueil périodique des découvertes dans les sciences chimiques et physiques, tant en France que chez l'étranger. Par J. B. van Mons. 6 vols., 12mo. Bruxelles, An x. [1801]-xii. [1804].
Cf. Journal de chimie pour servir [etc].
106. JOURNAL DE CHIMIE MÉDICALE, DE PHARMACIE ET DE TOXICOLOGIE. Rédigé par Chevallier, Fée, Guibourt, Julia-Fontenelle, Langier, Orfila, Payen, Gabrielle Pelletan, Lassaigue, Achard Richard, Robinet, Segalas d'Etchepare. 10 vols., 8vo. Paris, 1825-'34.

Continued under the title :

- [a] Journal de chimie médicale, de pharmacie et de toxicologie. Revue des nouvelles scientifiques nationales et étrangères. Par

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

les membres de la Société de chimie médicale. Deuxième série. 10 vols. (I.-X.), 8vo. Paris, 1835-'44.

Table générale des matières et des auteurs de la deuxième série du Journal de chimie médicale, de pharmacie et de toxicologie; de 1835-'44. 1 vol., 8vo. Paris, 1845.

Continued under the title :

- [b] Journal de chimie médicale, de pharmacie, de toxicologie et revue des nouvelles scientifiques nationales et étrangères. Par les membres de la Société de chimie médicale, Béral, Chevallier, Dumas, Fée, Guibourt, Lassaigne, Orfila, Payen, E. Péligot, G. Pelletan, Pelouze, A. Richard, S. Robinet. Troisième série. 10 vols. (I.-X.), 8vo. Paris, 1845-54.

Continued under the title :

- [c] Journal de chimie médicale, de pharmacie, de toxicologie et revue des nouvelles scientifiques nationales et étrangères. Publié sous la direction de A. Chevallier. Quatrième série. 10 vols. (I.-X.), 8vo. Paris, 1855-'64.

Continued under the title :

- [d] Journal de chimie médicale, de pharmacie, de toxicologie et revue des nouvelles scientifiques nationales et étrangères. Revue industrielle. Publié sous la direction de A. Chevallier. Cinquième série. 12 vols. (I.-XII.), 8vo. Paris, 1865-'76.

United in March, 1876, with the Répertoire de pharmacie and continued under the title : Répertoire de pharmacie et journal de chimie médicale réunis, q. v.

107. JOURNAL DE CHIMIE pour servir de complément aux Annales de chimie et d'autres ouvrages périodiques français de cette science. Rédigé par J. B. van Mons. 6 vols., 8vo. Bruxelles, 1792-1804.

Cf. Journal de chimie et de physique.

JOURNAL DE LA SOCIÉTÉ CHIMIQUE RUSSE.
See Zhurnal russkova khimicheskova (etc.).

JOURNAL DE PHARMACIE.
See Bulletin de pharmacie.

JOURNAL DE PHYSIQUE, DE CHIMIE - - - Laméthérie.
See Introduction aux observations sur la physique [c].

JOURNAL DER CHEMIE.
See Allgemeines Journal der Chemie.

108. JOURNAL DER PHARMACIE FÜR AERZTE UND APOTHEKER. Herausgegeben von Joh. B. Trommsdorff. 26 vols., 8vo. Leipzig, 1793-1826.

Continued under the title :

- [a] Neues Journal der pharmacie für Aerzte, Apotheker und Chemiker. Herausgegeben von Joh. B. Trommsdorff. 27 vols., 8vo. Leipzig, 1817-'34.

United in 1834 with the Annalen der pharmacie' q. v.

(To be continued).

Presence of Arsenic in Commercial Chloride of Lime and in Potassium Chlorate.—L. Garnier.—The author insists on the necessity of never attempting to attenuate the effects of putrefaction, in any organs reserved for chemical analysis, by the addition of any antiseptic or disinfectant whatever which may introduce a poisonous substance, and occasion trouble, if not error. He has also found arsenic in potassium chlorate, which is used to destroy organic matter in the search for metallic poisons by the process of Fresenius and Babo.—*Journal de Pharmacie et de Chemie*, vol. xii., No. 1.

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Prof. CHAS. E. MUNROE, U.S.N.A.

By far the most complete and valuable original contribution to the study of explosives which has been made in the United States is the work of General Henry L. Abbott, Eng. Corps, U.S.A., which has been published by the War Department, under the title "Report upon Experiments and Investigations to develop a System of Submarine Mines for Defending the Harbours of the United States," being No. 23 of the Professional Papers of the Corps of Eng., U.S.A. In a quarto of 444 pages, fully supplied with illustrations, diagrams, and tabulated data, General Abbott gives the results of thirteen years of experimental investigation and mathematical study of the data thus obtained.

The chief end of all the experiments was the determination of the distance at which a given charge of a given explosive would crush a ship of war as now constructed. Starting with an empirical formula, with its undetermined constants and its variables, embracing the various conditions involved in the explosion under water of mixtures and compounds converted almost instantaneously into gas, General Abbot has, by comparison and analysis of the measured results of a large number of experimental trials, brought it to a definite and determined form, giving a final expression for the absolute shock of the explosion as conveyed through water at different distances, at different depths, and in different directions. Incidentally, other questions of interest have arisen for solution and have met with experimental enquiry.

The first step in the investigation was naturally the experimental determination of the force of a unit weight of each explosive, and it became necessary to examine the relative value of the dynamometers available for the measurement of this force. The two forms which meet with general acceptance are Rodman's pressure gauge and Nobel's crusher gauge. Accepting the latter as more suitable for these experiments, it was decided to use lead cylinders, formed by casting and compression, to register the crushing force, rather than copper, since the latter metal is too hard for use in registering very small pressures even when a large diameter of piston is used. The requisite degree of sensitiveness was secured by employing five different sizes of lead cylinders to register the work of the explosion as transmitted by the piston, and to further extend the scale three different sizes of piston were adopted. To measure the compression of the cylinders, use was made of a standard scale having one fixed and one sliding contact piece, and reading by a vernier correctly to one-thousandth of an inch. The rapidity and accuracy of this method leave nothing to be desired.

The mathematical problem of so interpreting the lead compressions effected by a subaqueous explosion as to derive from them a correct idea of the destructive effect likely to be exerted upon a ship required careful consideration.

At the instant of explosion, a certain quantity of gas, depending upon the nature and weight of the charge is developed with a degree of suddenness varying with its chemical composition and the mode of ignition. The free expansion of this gas being resisted by the inertia developed in the water, a certain amount of mechanical work is instantaneously performed, resulting in the formation of a chamber filled with the highly heated products of the chemical reaction. The pressure of the surrounding water, joined to the original impulse, gives a rapid motion to this chamber along the line of least resistance, which in general coincides with the vertical drawn through the centre of the charge. A rush of gas and water into the

* From No. 24 of the *Proceedings of the U.S. Naval Institute*.

As it is proposed to continue these notes from time to time, authors, publishers, and manufacturers will do the writer a favour by sending him copies of their papers, publications, trade circulars, or expert testimony in infringement cases.

air is the result; which, in the case of a large charge exploded near the surface, often presents an imposing spectacle. This phenomenon is analogous to what occurs at the discharge of a cannon. The line of least resistance corresponds to the axis of the bore, while the water around plays the part of the metal of the gun.

A vessel in the vicinity may be exposed to three distinct dangers:—1st. Its hull, embedded in the aqueous cannon, may be ruptured by the initial shock transmitted from molecule to molecule through the fluid. 2nd. Should the hull be situated near the vertical through the charge its resistance may prove to be less than that of the superincumbent water, and the line of least resistance may thus be deflected from its normal direction and traverse the vessel. 3rd. In the case of the enormous charges sometimes employed in submarine mining, the waves generated by the explosion may rack the vessel beyond its power of endurance, or by rising amidships may even break her asunder.

Unless an actual vessel be available for the experiment it is evident that the pressure-gauge can only be arranged to measure the first of these three causes of destruction. The instrument virtually forms part of the aqueous cannon, and chiefly registers the kinetic energy transmitted from molecule to molecule of the fluid. Fortunately this is the primary cause of rupture, and conclusions based upon the gauge indications may therefore be accepted as the best attainable of the destructive force of the explosion.

To rupture the bottom of a vessel is to perform mechanical work; that is, there must be an effective motion of the point of application of the force along the line of its direction. This motion being much greater than in the bursting of a cannon, *time* becomes a more important element. Hence, in comparing different explosives under varying conditions as to distance, submergence, mode of ignition, &c., regard must be had to the amount of mechanical work to be performed rather than to the intensity of the forces developed; but it must not be forgotten that a certain amount of the latter is needful to overcome the resistance of the hull suddenly, before the available energy can be dissipated upon the water or upon a general lateral movement of the ship. In fact, it is possible to conceive that with the same potential energy an explosion may be so sudden and short-lived as to fail to supply the continuous force necessary to effect the destruction of the hull; or, on the other hand, that its force may be developed so slowly as to be expended in general harmless motion. It would appear, therefore, that the *mean intensity* of the force acting upon the ship during the time of explosion is the quantity most important to be determined.

In 1865 Prof. W. H. C. Bartlett, in a paper read before the National Academy of Sciences, criticised the method of Rodman of attempting to evaluate the cut produced on the copper in the gauge of a gun by a comparison with the cut produced by pressure in his machine, and he pointed out the difference in effect which must necessarily exist between the dynamic action of the gases and the static pressures of the machine. To avoid this error Gen. Abbot constructed a pendulum of considerable weight, and fixed his crusher-gauge rigidly at such a point that it would receive the full force of the blow from the hammer falling through a measured arc. The value of the compression of the cylinder was thus determined in foot-pounds. To connect this with the mean pressures recorded by the Rodman machine he exposed copper disks to the action of the Rodman indenting tool under the same circumstances. Other improvements were the invention of a device to exclude water from the gauge and a clutch to prevent the hammering of the piston.

Two forms of apparatus were employed for holding the gauges during the experimental explosions. First, the Ring apparatus, devised by Major King in 1865, of which four sizes, 3, 4, 5, and 8 feet respectively in interior diameter, were employed. They were made of the best wrought-iron, 1.5 inches thick, and 4.5 inches wide in the plane of the ring. Each ring held six gauges equi-

distant from each other, and the ring was suspended vertically. The buoy supporting the ring had also a gauge inserted in its bottom. Second, the Crate apparatus, used for measuring the energy developed by an explosion in the immediate vicinity of the torpedo, and at certain points vertically over it. It consisted of a rectangular wrought-iron frame 50 feet long, 10 feet wide, and 10 feet deep, and it carried 36 gauges. The two buoys supporting it were also each supplied with a gauge. In the course of the experiments it became evident that the gauges must be held rigidly in position, and this condition was fulfilled in the Crate apparatus. In both apparatuses the charge was held in the centre. Charges of from 5 to 50 pounds of dynamite were used with the crate, and it was finally destroyed by a charge of 100 pounds. Experiments were also conducted against wooden and iron targets representing a section of a modern ship of war.

The height and form of a jet of water thrown into the air by a given charge is observed to vary enormously with its submergence, and is probably a delicate index of the combined effect of all the forces transmitted to the surface of the water. It might seem that this feature could be turned to account in studying certain important matters, such, for example, as the effect of varying the strength of case for gunpowder charges, and Capt. Vandevelde, of Holland, based his system of subaqueous measurements upon it. The subject was carefully investigated, both instrumentally and by the aid of instantaneous photography, and it was found that the disturbing action of even very slight currents of air; the varying effects dependent upon the relative position of the sun, the jet, and the observer; the excessive tenuity of the ill-defined cloud of mist which shrouds the main body of water; and, lastly, the rapidity with which the different phases succeed each other, combine to throw too much uncertainty upon the phenomenon to render it a safe basis for important practical conclusions.

In using the Ring apparatus with explosive *mixtures* it was observed that in each individual shot there was a decided maximum intensity in *some* direction, owing probably to the case holding the charge giving way at that point, but the study of the final results proved that, with explosive *mixtures*, there is no well-marked difference in the initial intensities of action in different directions in a vertical plane passing through the centre of explosion, when the number of observations is sufficiently multiplied to eliminate the disturbing effect of anomalies.

In the study of the characteristics of the subaqueous explosions it was determined to examine fully only one typical explosive of each class, trusting that a few shots, carefully planned, would develop the peculiarities of others of the same general nature. Mortar powder was selected as a fair type for chemical mixtures, and dynamite No. 1 for chemical compounds. For comparison with mortar powder other varieties of gunpowder, together with Oliver powder (in which part of the carbon was replaced by uncarbonised peat) and the Oriental Safety compound (consisting of gambier and potassium chlorate) were taken. In order to compare the strength of dynamite No. 1 in subaqueous explosions with that of other explosive compounds, shots were fired with gun-cotton, dualine, nitro-glycerin, dynamite No. 2, mica powder, vulcan powder, rendrock, hercules powder, electric powder, Designolle powder, Brugere or picric powder, and explosive gelatin.

In comparing the results obtained for pure nitro-glycerin with those for dynamite No. 1 there was revealed what at first sight appears to be a paradox. One pound of pure nitro-glycerin was found to exert only 81 per cent of the intensity of action of three-fourths of a pound absorbed by an inert substance which could add nothing to the heat or gases developed. This fact, which was discovered early in the trials, was considered so extraordinary as to require careful verification and study. The first explanation suggested was that it was due to a possible variation in the strength of the nitro-glycerin itself

depending upon a difference in the chemical composition of different samples. This was tested practically with different nitro-glycerins, and with nitro-glycerin and dynamite made from it, and it was shown beyond question that variations in the quality of the nitro glycerin had nothing to do with it, and that the explanation must be sought in the physical conditions of the problems. General Abbot, therefore, suggests that in granulating nitro-glycerin, by absorbing it in kieselguhr, the particles of silica slightly retard chemical action—since in detonation the reactions occur within the molecules—and as the resistance opposed by water is of a slightly yielding character, more time may be required to reach this condition than is afforded by nitro-glycerin pure and simple. This view is confirmed by the action of certain dynamites which are so prepared as to explode with exceeding rapidity and which fall very low in the scale. They are evidently so quick as to be unsuited for subaqueous work.

As the result of this branch of his investigation, General Abbot concludes that, as regards permanency, power, convenience, and readiness in manufacture, dynamite No. 1 is the best explosive for our submarine mines. Hence, in studying the destructive effect of subaqueous explosions, this compound was exclusively used. In the discussion of the results obtained comparisons were made with those obtained in England, France, Sweden, and elsewhere.

As a result of this investigation it is found that if we adopt an instantaneous pressure of 6500 lbs. per square inch as the measure of a fatal shock to a first-class ship of war, the following are the extreme destructive ranges of submarine mines:—

	Charge, pounds.	Horizontal Range, feet.	Vertical Range, feet.
Dynamite No. 1	100	16'3	18'6
Gun-cotton	100	14'7	17'3
Explosive gelatin.. .. .	100	18'2	20'3
Sporting powder, 1 fuse per cub.ft.	100	3'3	3'3
" " 1 central fuse..	100	3'1	3'1
Dynamite No. 1	200	22'6	25'9
Gun-cotton	200	20'5	24'1
Explosive gelatin.. .. .	200	25'3	28'2
Sporting powder, 1 fuse per cub.ft.	200	7'4	7'4
" " 1 central fuse..	200	6'6	6'6
Dynamite No. 1	500	35'0	40'0
Gun-cotton	500	31'7	37'3
Explosive gelatin.. .. .	500	39'1	43'7
Sporting powder, 1 fuse per cub.ft.	500	19'5	19'5
" " 1 central fuse..	500	16'2	16'2

The smallness of the additional range obtained by increasing the charge from 200 to 500 lbs. has led to the adoption of the 200-lb. charge for shallow harbours.

The general formula for the extreme destructive range (Δ) of a submarine mine charged with an explosive compound and acting upon a first-class ship of war, which has resulted from this investigation and from which the foregoing table has been computed, may be placed under the following form, for convenience of application:—

$$\Delta = \frac{2 \cdot 1}{8} \sqrt[3]{(\theta + E)C} \text{ in which}$$

Δ = range in feet.

C = the weight of the explosive in pounds.

E = a constant to be determined by experiment. (It is for dynamite 186, and for gun-cotton 135.)

θ = the angle with the vertical passing through the centre of the charge, made by a line drawn from that point to the surface exposed to the shock, reckoned from the nadir and expressed in degrees.

If the vessel lies at this or a less distance she will be destroyed; if at a greater distance she will escape rupture of the hull. A submergence of the charge properly suited to its size is supposed, say, not less than 3 or 4 feet for 100 pounds, and proportionately greater for larger amounts.

By this mode of treatment the results are made general. Suppose, for example, that the strength of the hulls of ships of war should be increased. A corresponding change in the constant E would indicate the new requirements. Suppose that some new explosive compound should prove to be better suited to the work than dynamite. A new value for the constant E is all the change that would be required. It will therefore be comparatively easy hereafter to keep pace with modern progress.

The remainder of the report is devoted to the investigations of electrical fuses and of the various forms of igniting apparatus; and it is distinguished by the same fulness, accuracy, and thoroughness which characterise the portions abstracted. The appendices contain full details of upwards of 700 explosions, which may be used in any further discussion of this subject.

A new form of dynamite is proposed, in which 90 parts of dynamite or blasting gelatin are mixed with 10 per cent of india-rubber in sufficient solvent to dissolve it. The whole is thoroughly stirred and the solvent evaporated; the mixture is then packed in rubber cartridges.—*Journ. Soc. Chem. Ind.*, and *School of Mines Quarterly*, iv., 3, 239, April, 1883.

The *School of Mines Quarterly*, iv., 1, Sept. 15, 1882, contains a paper by Arthur H. Elliott, F.C.S., "On Nitro-glycerin," which records the solvent action of a large number of substances on nitro-glycerin. In making these experiments it was found impossible to heat nitro-glycerin near the boiling-point of water without some of it evaporating. Ammonic sulphhydrate and ferrous chloride both reduced nitro-glycerin when hot. The action of ammoniac sulphhydrate is shown thus:—

Two quantities, 3'847 and 3'758 grms., of nitro-glycerin were each dissolved in 25 c.c. of absolute alcohol, and each was treated with about 50 c.c. of ammoniac sulphhydrate solution (made by saturating ammoniac hydrate, sp. gr. 0'98, with sulphuretted hydrogen). The solutions became hot, dark coloured, and sulphur separated, which dissolved again when more ammoniac sulphhydrate was added, much ammonia being given off during the action. The solutions were now evaporated to dryness, to expel the excess of ammonia and ammoniac sulphhydrate. The residue containing separated sulphur was treated with water, the solution filtered, and the residue washed with water. The filtered solution and washings were now evaporated until the weight was constant. The glycerin so obtained weighed 1'552 and 1'540 grms., which is equal to 40'34 and 40'97 per cent on the nitro-glycerin taken, while the theoretical figures are 40'52 per cent. Ammonic sulphhydrate, therefore, reduces nitro-glycerin, and gives practically the theoretical quantity of glycerin.

In the paper of Prof H. Debus on the "Chemical Theory of Gunpowder" (*Nav. Inst. Proc.*, ix., 1, March, 1883), on page 74, he repeats the error concerning the composition of the United States regulation powder which is found in many foreign books. The United States regulation gunpowder is composed of 75 parts of saltpetre, 15 parts of charcoal, and 10 parts of sulphur.

From *Census Bulletin*, No. 304, we learn that there were in 1880, in the United States, 39 factories for the manufacture of explosives and fireworks, having a capital of 579,750 dols., and employing 313 men, 217 women, and 205 youths. The wages paid during the year amounted to 216,069 dols.; the value of the materials was 840,877 dols., and of the products 1,391,132 dols. Thirty-three establishments, with a capital of 4,983,560 dols., were devoted to gunpowder; 988 men, 20 women, and 3 youths were employed. The wages amounted to 510,550 dols.; the value of the materials to 2,053,488 dols., and of the products to 3,348,941 dols. There were 21 factories for the high explosives, with a capital of 1,605,625 dols.; 328 men and 1 woman were employed, and their wages were 164,864 dols. The value of the material was 1,218,061 dols., and of the product 2,453,088 dols.

Under the title "Dust Explosions in Breweries," C. John Hexamer gives in *Journ. Frank. Inst.*, [3], lxxxv,

2, 121, February, 1883, an account of the causes of these explosions, and the precautions to be taken and devices invented for preventing them. He especially dwells upon the necessity of removing bits of iron from the grain by passing it over a plate magnet, the lining of the elevator with copper, and the use of geared rollers with spring clamps in place of friction rollers.

In the same journal, page 135, in a "Summary of Progress in Science and Industry for 1882," reference is made to the use of caustic lime as a substitute for gunpowder in coal mines. The lime is made into cartridges by a hydraulic pressure of 40 tons. By a simple and inexpensive method these cartridges are confined in the bore holes in such a manner that when a quantity of water is forced into contact with them, the combined effect of the steam generated and the expansion of the lime in slacking breaks the coal out in from ten to fifteen minutes, and without wastage from pulverisation. The process has been in use now for some time, and works well.

Mem. Soc. Eng. Civ., September, 1882, page 270, gives an interesting and detailed account of the removal of an iron wreck in the channel of the Danube, which was dangerous to shipping: 790 kilos. of explosive gelatin and 475 kilos. of dynamite No. 1 were used, the former costing 1 dollar per kilo., and the latter 64 to 80 cents per kilo., in Vienna. The total cost of removal was 7250 dollars, and the work occupied two months.

(To be continued).

CORRESPONDENCE.

AN APPARATUS FOR CONTINUOUS EXTRACTION OF SOLID SUBSTANCES BY VOLATILE SOLVENTS.

To the Editor of the Chemical News.

SIR,—I am in receipt of a note from Mr. Wyndham R. Dunstan, Demonstrator of Chemistry in the University Laboratories, Oxford, drawing my attention to a paper of his published in the *Pharmaceutical Journal* about February, 1883, in which he describes a modification of Tollens's apparatus the same in principle as that described by me in the *CHEMICAL NEWS*, vol. li., p. 39. I think it right to take this opportunity of acknowledging Mr. Dunstan's priority in the matter, and of assuring your readers that I was in entire ignorance of the existence of his paper alluded to.—I am, &c.,

G. STILLINGFLEET JOHNSON.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, del'Académie des Sciences. Vol. ci., No. 3, July 2, 1885.

Spectral Study of Bodies rendered Phosphorescent by the Action of Light or by Electric Discharges.—Edm. Becquerel.—(See page 76.)

On Thorium Metaphosphate.—L. Troost.—In various memoirs it has been recently admitted that thorina has the composition of a dioxide instead of that of a protoxide as proposed by Berzelius. The new view is supported by the isomorphism between thorina and zirconia, pointed out by Nordenskiöld and Chydenius, the analogy of form which Brögger thought he perceived between the microscopic crystals of thorium and silicon,

and by Nilson's determination of the specific heat of thorium. Hence thoria has been considered analogous to zirconia and silica. Still, in certain known compounds, thoria behaves like a monoxide. The author has undertaken the study of this question. He finds that thoria metaphosphate presents no analogy, either in composition or crystalline form, with silica metaphosphate, and hence furnishes no evidence in favour of the dioxide theory.

Capillary Constants of Saline Solutions.—A. Chervet.—A mathematical paper, not admitting of useful abridgement.

Production of the Lowest Possible Temperatures.—K. Olszewski.—In a former memoir (*Comptes Rendus*, xcvi., p. 365), the author describes the apparatus which enabled him to eliminate the influence of ethylene upon liquefied gases, and to obtain very low temperatures by means of oxygen and of air evaporating in a vacuum. In a subsequent series of experiments the author has further introduced into his apparatus a second tube of very thin glass, and thus isolates the liquefied gases by a double gaseous stratum. The pressure and the temperature being then considerably lowered, he has been able to solidify nitrogen, carbon monoxide, formene, and nitrogen dioxide, and to determine at the same time the temperatures of solidification. By reducing the pressure of solid nitrogen down to 0.004 metre of mercury he has succeeded in obtaining the lowest temperature known, -225° .

Condition of Charge and of Discharge in Accumulators.—MM. Crova and Garbe.—The authors conclude that the potential corresponding to the condition of charge is constant as long as the register traces its inclined right line; the gaseous escape is not an index of saturation. It is a cause of loss of energy and of the destruction of the stratum.

Electric Resistance of Alcohol.—G. Foussereau.—Various samples of the absolute alcohol of commerce present at the temperature of 15° specific resistances from 2.47 to 3.68 megohms.

Formation-Heats of Certain Phthalates.—M. Colson.—Not adapted for abstraction.

Certain Facts of Oxidation and Reduction produced by the Microbia of the Soil.—A. Muntz.—The author has examined if the nitrates of Peru in which iodine exists as iodate, contain also bromine as bromate. The result has been affirmative. Not only potassium iodate, but the bromate, and even the chlorate, are rapidly reduced in presence of the reducing agents of the soil.

Variation of Physical Properties in the Chloroacetic Derivatives.—L. Henry.—Certain physical properties, such as volatility and density, are modified in a progressive and gradual manner. In other properties, such as fusibility, the modification is alternating.

Journal de Pharmacie et de Chemie.

Series 5, Vol. xii., No. 2, July 15, 1885.

Nitro-derivatives of Ethylen Hydride.—A. Villiers.—Already noticed.

Olives on Branches: a Manner of Preservation.—Stanislas Martin.—A paper of no chemical or physical interest.

Incandescence of a Platinum Spiral.—Felix Belamy.—The author gives an illustrated description of an arrangement for experimenting on this phenomenon, and adds a list of substances which readily produce incandescence, a list of substances which produce it with difficulty, and, finally, a list of such as never produce it. The bodies of the first group are all highly hydrogenised; all, except ammonia, contain carbon, and they are slightly or not at all oxygenated. Their vapour ignites more or less easily. The bodies of the second class, except mercaptan, are composed of the same elements as those of

the first class. They are less combustible. Mercaptan, though very combustible, produces incandescence very imperfectly. The last group contains carboniferous bodies, which, except carbon disulphide, are sparingly combustible. With the same exception, and that of nitro-benzol, they contain chlorine, bromine, or iodine, as constituent elements.

Rapid Assay of the Glaze of Common Earthenware.—M. Herbelin.—Lead oxide, melted or incompletely vitrified, is still in common use in the manufacture of inferior earthenware, and sometimes leads to serious results. To detect lead in a glaze M. Herbelin moistens a slip of white linen or cotton, free from starch, with nitric acid at 10 per cent, and rubs it for ten to fifteen seconds on the side of the utensil under examination, and then deposits a drop of a solution of potassium iodide, at 5 per cent, on the part which has been in contact. A lead glaze simply fused gives a very highly-coloured yellow spot of potassium iodide; a lead glaze incompletely vitrified gives spots the more decided, the less perfect the vitrification; and a glaze of good quality gives no sensible colour at all.

Detection of Chlorides in Potassium Bromide and Iodide.—L. L. de Koninck.—This paper will appear in full.

Impurities in Methylic Alcohol.—M. Schlagdenhauffen.—The author found, in a sample which he examined, lead oleate and stearate. He considers that it must have been used in place of ether for the separation of lead stearates and oleates, and had been afterwards carelessly rectified. It is needless to say that an impurity so unexpected might give rise to the most lamentable errors.

Mercurial Poisoning from the Use of Fulminating Caps.—P. Marie and A. Londe.—It appears that the proprietors of two shooting-galleries were affected with the ordinary symptoms of mercurial poisoning. It is recommended that shooting galleries should be well ventilated, and that when this is not possible non-mercurial caps should be used.

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Biedermann's Central Blatt für Agrikultur Chemie.
Vol. xiv., No. 1, January, 1885.

Knowledge of Thunderstorms.—Ciro Ferrari.—The author and Von Bezold had previously observed that very extensive thunderstorms are often attended at their rear by small, well-marked depressions, and that the anterior margin of a thunderstorm forms the boundary between a region of high pressure and one of low pressure. In the country visited by the storm the rain districts assume the form of ellipses, whose major axes are almost parallel to the direction of the storm. Hail forms long narrow bands, coinciding in direction with that of the prevalent wind.

Influence of Temperature on the Hygroscopicity of Arable Soil.—Th. Schlösing.—From the *Comptes Rendus*.

Influence of Tillage upon the Relations of Humidity of the Soil.—Arpad Hensch.—The influence of the mechanical treatment of the soil is manifested in three directions. The direct action is merely mechanical, affecting the texture of the particles of the soil, and thus effecting on the one hand a more even distribution of plant-food, and on the other the removal of many hindrances to the development of the plants. Its indirect action affects the physical and chemical condition of the soil, modifying its temperature and ventilation, and converting the plant-food existing in the soil more rapidly into an assimilable condition. The magnitude of evaporation differs greatly in different soils. According to Eser's experiments humous soils evaporate most and sands least, clays occupying an intermediate position. In general a soil throws off more water the moister it is. Even with equal quantities of water the evaporative power varies

according to the texture of the soil and the nature of its surface. A soil which has been rolled is at first moister in its upper layers than one which has been left rough; in case of prolonged drought the rolled soil dries up more rapidly and to a greater extent than one left rough. Shallow ploughing or harrowing, causing a superficial looseness, preserves the moisture of the deeper strata.

Phosphoric Acid in Arable Soils.—P. de Gasparin.—In a mixture of mineral and vegetable detritus, as washed by rain from rocks covered with mosses and lichens the organic portion is much richer in phosphoric acid than the inorganic.

The Loss of Nitrogen in Putrescent Animal Matter.—Dr. A. Morgen and Prof. J. König.—A portion of the nitrogen of organic matter passes into the free state on putrefaction, and is consequently lost. An addition of gypsum or of kainite diminishes, or in some cases completely does away with, the loss of nitrogen.

Field Experiments with Turnips.—B. Dyer.—From the *Journal of the Royal Agricultural Society*.

Vol. xiv., No. 2.

Activity of Lower Organisms on Arable Soils.—E. Wollny.—In this section the author discusses practical measures for regulating the organic processes.

The Absorptive Power of Sandy Soils.—Prof. E. Heiden.—It appears, from the experiments described, that the absorptive power of a sandy soil is not so small as it is commonly supposed.

Examination of the Value of Various Nitrogenous Manures.—Dr. E. von Eckenbrecher.—The author's experiments show that nitrogen in crude (Megillones) guano is almost useless; in blood, ground bones, and horns its action is more favourable, and little inferior to that of ammonium sulphate. Trimethylamin is equal to the last-mentioned salt.

Behaviour of Salts of Zinc with Plants and with the Soil.—Anton Baumann.—The presence of zinc in plants has been repeatedly observed, and not only in such as grow near deposits of zinc ores, but also, though in minute quantities, in plants where no zinc could be traced in the soil. From a number of experiments the author found that the injurious action of zinc sulphate in solution was more considerable than it had been assumed. In solutions of 1 m.g. zinc per litre all plants vegetated undisturbed, whilst with 5 m.g. per litre all perished. Old plants of any kind died more rapidly than young plants. Insoluble compounds of zinc in the soil—such as zinc oxide, sulphide, and carbonate—have no perceptible action. The poisonous action of zinc on plants seems to depend on the destruction of the chlorophyll.

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Justus Liebig's Annalen der Chemie,
Vol. ccxxix., Part 3.

Contribution to a Knowledge of the Fat or Wax obtained from Cinchona Barks.—O. Hesse.—From the Cuprea barks the author obtains cupreol, a compound which in all points resembles quebrachol. It crystallises from alcohol in colourless satiny leaflets, which quickly become dull in dry air. It is readily soluble in chloroform, ether, and hot alcohol; less readily in petroleum ether and cold alcohol; and in water, ammonia, and potash-lye not at all. It melts at 140°, and at higher temperatures it volatilises unchanged in a current of hydrogen or carbonic acid. The solution in chloroform, when shaken with sulphuric acid of 1.76 sp. gr., turns a blood-red, as do the chloroform solutions of quebrachol, cholesterin, or phytosterin. Cinchol occurs in all true cinchona barks, but not in cuprea bark. From hot alcohol it crystallises partly in long, almost acicular, leaflets, partly in broad leaves, and always with 1 mol. of water. It loses a part of its water at 20° to 25°, and the rest at 100° or in the exsiccator. Anhydrous cinchol melts at 139°, and in other respects possesses the same properties as cuprol.

The Action of Phosphorus Pentachloride upon Salicylic Acid.—R. Anschütz.—The author undertook a series of experiments in the expectation that salicylic acid chloride would display intermolecularly, and with the formation of anhydride, the same action of the CO Cl-group upon the OH-residue as we see occurring extramolecularly by the action of a carbon acid chloride upon a phenol. The result was, however, different from his expectations.

Communications from the Chemical Institute at Marburg.—These consist of a paper, by M. Niemeyer, on chlorinised quinons and hydroquinons; and one by M. Henius, on the ammonia-derivatives of benzil.

NOTES AND QUERIES.

* * Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Micro-organisms in Water.—I shall be much obliged if you will allow me to say that experiments in this direction have been continued in my laboratory since the end of last year, and that Dr Koch's method of determining the number of organisms has been employed by me, as I see it has been by Dr. P. Frankland. The manuscript of a note on this subject has been in the hands of the secretary of the Institution of Civil Engineers since May last, and it will be published in the forthcoming volume of the Transactions. I may say, however, that my experiments have been confined to determining the sterilising effect of metallic iron as employed in the revolving purifying apparatus patented by Mr. W. Anderson, a member of the Institution, and in the case of metallic iron only have my experiments anticipated the valuable researches of Dr. P. Frankland.—G. H. OGSTON.

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THE CHEMICAL NEWS.

VOL. LII. No. 1343.

ESTIMATION OF PHOSPHORIC ACID IN COMMERCIAL PRODUCTS.*

By H. JOULIE.

AFTER pointing out at considerable length the precautions necessary in sampling manures in bulk, the author proceeds to describe the management of the sample placed in the hands of the chemist, and insists on the importance of rendering this perfectly uniform, and at the same time of guarding against, or ascertaining the extent of, any alteration in the proportion of moisture brought about by these preliminary operations.

The estimation of phosphoric acid in any form of combination being of more importance than processes adapted only for particular cases, the author recommends, as first in speed and accuracy, his own citro-uranic method; in a few cases it may be preceded by Sonnenschein's molybdc precipitation. The exact course of proceeding recommended, together with the author's critical notes on alternative details, may be usefully summarised.

Citro-uranic Process.—One to 10 grms. of the sample are dissolved in hydrochloric acid. Some chemists use nitric acid with a view of leaving as much ferric oxide as possible undissolved. This course is condemned by the author, because the presence of ferric salts in no way interferes with the citro-uranic process, and because hydrochloric acid is a much better solvent of mineral phosphates than nitric acid, and leaves a residue free from iron, by the whiteness of which one may judge of the completeness of the attack. In the case of phosphates containing a little pyrites, nitric acid should be used in conjunction with hydrochloric. The removal of silica by evaporation to dryness is necessary only in those cases where the sample contains silicates decomposable by hydrochloric acid, with separation of gelatinous silica. The sample is boiled with the hydrochloric acid in a measuring flask until the residue is perfectly white, the contents are cooled by immersing the flask in water, made up to the mark with cold distilled water, mixed, filtered through a dry filter, and such a fraction of the filtrate withdrawn by an accurate pipette as contains about 50 milligrams. of phosphoric anhydride. The best pipettes for the purpose have straight, almost capillary, tubes, and are gauged between two marks. The sample being delivered from the pipette into a test-glass, 10 c.c. of citro-magnesian solution are added, and then a large excess of ammonia. If this quantity of citro-magnesian liquor is sufficient no precipitate will form until the lapse of a few moments; should an *immediate* precipitate form it is iron or aluminium phosphate. In this case a fresh sample must be pipetted off, and 20 c.c. citro-magnesian liquor added; it is of no use adding another 10 c.c. of the citric solution to the original sample, as the precipitated phosphates of iron and aluminium do not readily re-dissolve when once formed. The citro-magnesian liquor is made after Millot, thus:—Citric acid 400 grms., magnesium carbonate 40 grms., distilled water 500 c.c. When solution has taken place add say 600 c.c. ammonia to render the liquid strongly alkaline, and dilute to 1500 c.c. This solution will keep without growing a mould. The old plan of adding first citric acid and then "magnesia mixture" to the solution under analysis frequently leads to incomplete precipitation of the phosphoric acid, because the ammonio-magnesium phosphate is slightly soluble in ammonium citrate unless a sufficient

excess of magnesium salt is present, and therefore the quantity of magnesium salt should be increased *pari passu* with the citric acid required, which is best done when they are in solution together. The liquid after precipitation is allowed to stand from 2 to 12 hours under a bell glass (to prevent evaporation of ammonia), and is then decanted through a small filter fitted in a funnel with a long neck of 2 m.m. bore. These funnels are conveniently placed in a stand holding a series of 6 or 8, and filtration is so quick that as soon as the operator has filled No. 8, No. 1 is ready for a second charge. The precipitate remaining in the test-glass is washed with ammonia ($\frac{1}{10}$) by decantation, and then on the filter until the filtrate gives no precipitate with sodium phosphate. Four washings generally suffice, and thorough washing is by no means so essential to this process as to the ordinary gravimetric one. Dilute nitric acid ($\frac{1}{10}$) is next poured into the test-glass to dissolve the precipitate adhering to the glass, thence on to the precipitate on the filter. The nitric solution is received in a beaker holding about 150 c.c. and marked at 77 c.c. After two or three washings with acidulated water the filter itself is detached from the funnel and added to the contents of the beaker, as the paper is found to retain traces of phosphoric acid even after many washings. Dilute ammonia ($\frac{1}{10}$) is next added until a slight turbidity is produced, which is removed by the addition of one or two drops nitric acid, the liquid is heated to boiling, 5 c.c. of the sodium acetate solution added, and the titration with uranium nitrate immediately proceeded with. The sodium acetate solution contains 100 grms. of the salt and 50 grms. glacial acetic acid in one litre. The standard uranium nitrate is made by dissolving about 40 grms. of the pure crystals in 800 c.c. water, adding a few drops of ammonia to produce a slight turbidity, then acetic acid until cleared, and diluting to 1 litre; acetate of uranium should not be used, as it impairs the sensibility of the end-reaction. The uranium solution is titrated by trial with 10 c.c. of a standard solution of acid ammonium phosphate containing 8.10 grms. of the pure dry salt per litre (1 c.c. = 0.005 grm. P_2O_5). The ammonium phosphate solution is verified by evaporating a measured quantity (say 50 c.c.) of it to dryness with a measured quantity of a solution of pure ferric nitrate containing an excess of ferric oxide, and calcining the residue. The difference in weight between this calcined residue and that from an equal volume of ferric nitrate solution evaporated alone is the weight of phosphoric anhydride contained in the 50 c.c. of ammonium phosphate solution. The actual standardisation of the uranium nitrate is performed by measuring accurately 10 c.c. of the ammonium phosphate into a beaker marked at 75 c.c., adding 5 c.c. of the sodium acetate, making up with water to about 30 c.c., and heating to boiling. 9 c.c. uranium is then run in from a burette, and the liquid tested in the usual way with potassium ferrocyanide. From this point the uranium is added two or three drops at a time, until the end-reaction just appears, the burette being read off at each testing. As soon as the faintest colouration appears immediately, the beaker is filled to the mark with boiling distilled water, and another test made. If the operation has been properly conducted no brown colour will be detected, owing to the dilution of the liquid, and one or two drops more of the uranium solution must be added before the colour becomes evident, and the burette is finally read off. A constant *correction* is subtracted from all readings obtained in this way: it is the quantity of uranium found necessary to give the end reaction with 5 c.c. of the sodium acetate solution alone, diluted to 75 c.c. with boiling water as above described. The end-point must always be verified by adding three or four drops of uranium in excess, and testing again, when a strongly marked colour should be produced. The standard uranium is made of the same strength as the standard ammonium phosphate in order to eliminate the error caused by changes in the temperature of the laboratory. The actual analysis is made in the same way as the

* *Ann. Agronom.*, xi., 97-129.

titration of the standard uranium, except that a slight error is introduced by the number of tests that have to be made abstracting a small fraction of the assay. To correct this, a second estimation should always be made, and nearly the whole of the uranium found necessary in the first trial should be added at once. Tests are then made at intervals of two or three drops, and the final and correct result should slightly exceed that obtained in the first trial. The test-liquors should be verified every three or four days, or at least as often as the temperature of the laboratory undergoes any important change.

As regards weighing the precipitated ammonio-magnesian phosphate as magnesium pyrophosphate, the following errors are incidental to this mode of proceeding.

It is not easy to detach and transfer to the filter completely and without loss the small quantity of precipitate which adheres to the beaker. Calcination always leaves a grey residue containing carbon. The precipitate generally contains, in addition to ammonio-magnesium phosphate, one or more of the following:—Silica, oxide of iron, lime, and, above all, excess of magnesia. Silica can of course, be got rid of by an initial evaporation to complete dryness (which consumes much time); ferric oxide is present only when sufficient citric acid has not been used; lime does not come down unless the precipitation is effected in too concentrated solutions; but excess of magnesia exists in all precipitates obtained with a sufficient quantity of citro-magnesian solution. On dissolving such a precipitate in acid, re-precipitating with ammonia, and allowing to stand twelve hours, a pure precipitate is obtained, the filtrate from which readily shows the presence of magnesia on testing with sodium phosphate. The process may in this way be rendered accurate, but at the same time longer and more troublesome than the volumetric method. The extra precautions necessary in adopting the gravimetric method are, in fact, (1), the removal of silica, (2) a much more thorough washing of the precipitate; (3), re-solution and re-precipitation with a large excess of ammonia; (4), re-washing with strong ammonia (1 : 2); (5), drying, calcining, moistening with nitric acid, re-drying, and re-calcining. The presence of *fluorides* renders even these precautions inadequate, as they are found in the precipitate, even after re-precipitation, and add to its weight, the error thus caused being sometimes very large; on the other hand, they do not sensibly affect the estimation by uranium nitrate, as the author shows by examples. Arsenic, in any case, must be absent, or must be removed from the hydrochloric solution by sulphuretted hydrogen.

Nitro-molybdic Method.—The precautions essential to the success of this method are the following:—Organic matter, if present, must be removed by calcination. Silica and chlorides must be eliminated by two or three evaporations to dryness with nitric acid. Nitric acid must be used for the solution, because the phosphomolybdate of ammonia is very sensibly soluble in free hydrochloric acid, in mixtures of nitric acid with alkaline chlorides and ferric chloride, and in solutions containing free hydrofluoric acid. Fluorides, however, are not decomposed by nitric acid, and hence have no influence. Free sulphuric acid slightly retards the appearance of the yellow precipitate, but sulphates are without influence. In the presence of chlorides and fluorides it is therefore advisable to heat the substance with sulphuric acid until white fumes begin to escape, to neutralise the sulphuric acid with soda, and then to boil with nitric acid. In the presence of iron a red residue containing ferric oxide is left undissolved by nitric acid, and to ensure the complete solution of phosphoric acid this residue must be boiled a second time with nitric acid after filtration and washing, and the second filtrate must be tested with the molybdic solution.

The author further recommends that the molybdic precipitation be finished up by titration of the ammonio-magnesian phosphate with uranium nitrate, after precipitation by the citro-magnesian reagent. He gives the

preference, however, on grounds of speed and accuracy, to the simple citro-uranic process, except in the case of soils and similar substances very poor in phosphoric acid.

J. M. H. MUNRO.

ADDENDA.

During the last few weeks I have employed the citro-uranic process, exactly as above described, for the estimation of phosphoric acid in materials containing a very large proportion of ferrous and ferric compounds in addition to phosphoric acid, much lime, and magnesia. In the ordinary way, these substances could only be assayed by the nitro-molybdic precipitation, followed by solution of the yellow precipitate in ammonia, and re-precipitation by "magnesia mixture." Joulie's direct precipitation of the P_2O_5 in a form suitable for the uranium process offers great advantages in speed and economy over this tedious and expensive procedure, and the only question is whether the methods are equal in point of accuracy. The results I have obtained have induced me to believe that the citro-uranic process, if carried out exactly as recommended by M. Joulie, is an accurate one, and is decidedly the best adapted for a series of P_2O_5 determinations in substances of the character I have been working with. As an example I may cite this morning's titrations, the corresponding precipitations having been effected overnight.

A. Phosphoric acid in sewage sludge containing much precipitated oxide of iron and alumina.

I. 50 c.c. solution = 1.25 grms. sludge. Uranium required 10.45—10.75 c.c.

II. 50 c.c. solution = 1.25 grms. sludge. Uranium required 10.85 c.c. = 4.15 p.c. P_2O_5 .

III. 50 c.c. solution = 1.25 grms. sludge. Uranium required 10.80 c.c. = 4.18 p.c. P_2O_5 .

The first titration is a rough one, and serves merely to mark the limits and so expedite the exact experiments II. and III., in which tests are made between every fresh drop of uranium solution added. The same sludge, assayed six weeks ago by Joulie's process with a different standard solution of uranium, gave P_2O_5 = 4.08 p.c. A gravimetric determination with molybdenum and magnesia mixture gave 4.17 p.c.

B. A substance containing 12 per cent of green vitriol in addition to peroxide of iron, lime, silica, magnesia, &c.

Total phosphoric acid.

I. 50 c.c. solution = 1.25 grms. substance. Uranium required 12.7 c.c. = 4.88 p.c. P_2O_5 .

II. 50 c.c. solution = 1.25 grms. substance. Uranium required 12.8 c.c. = 4.92 p.c. P_2O_5 .

Phosphoric acid soluble in water.

I. 70 c.c. solution = 1.4 grms. substance. Uranium required 12.35 c.c. = 4.24 p.c. P_2O_5 .

II. 70 c.c. solution = 1.4 grms. substance. Uranium required = 12.45 c.c. = 4.27 p.c. P_2O_5 .

This last determination offered special difficulty from the fact that a slow and simultaneous precipitation of ferric phosphate and calcium sulphate begins to take place immediately in the aqueous filtrate of the substance, and has proceeded to a considerable extent before the washing of the insoluble residue is completed. In Experiment I. a little hydrochloric acid was added to dissolve the ferric phosphate before the addition of Joulie's solution; in Experiment II. HCl was added and the solution warmed until both the ferric phosphate and calcium sulphate had dissolved. In a third experiment in which the Joulie solution was added direct to the turbid liquid only 11.4 c.c. uranium were required = 3.91 p.c. P_2O_5 , thus confirming M. Joulie's remark that ferric phosphate *once precipitated* is not easily decomposed by the citro-magnesian solution.

J. M. H. M.

College of Agriculture, Downton, Salisbury,
August 19, 1885.

NOTE ON THE
ACTION OF STANNOUS CHLORIDE UPON
NITRIC ACID.

By EDWARD DIVERS and TAMEMASA HAGA.

IN a short paper sent early in May to the Chemical Society, and which will probably appear in the CHEMICAL NEWS and elsewhere, we have described the observations made by us, up to the date of our sending it, upon the behaviour of stannous chloride towards nitric acid.

As there stated, nitric acid is only in part affected when it is added to a solution of stannous chloride which is merely strongly acidified with hydrochloric acid, and then, so far as it is changed at all, is converted into hydroxylamine unmixed with ammonia. When, however, as we have since found, the nitric acid is added to stannous chloride solution which has been saturated with hydrochloric acid, much more of it, if not all, is decomposed, with the development of considerable heat, and the formation of ammonia as well as of hydroxylamine. We believe that by sufficient care to prevent any great rise in temperature—which we have found to be not an easy matter—we may yet succeed in decomposing all, or nearly all, the nitric acid without generating any ammonia. We also believe that this ammonia does not come from any reduction of hydroxylamine, but from a mode of decomposition of the nitric acid different from that which occurs when hydroxylamine is the result. These points, however, we are investigating, and do not now desire to discuss, the object of this note being only to record our experience that ammonia is sometimes formed by the contact of nitric acid with stannous chloride. The difference is thus greatly lessened between von Dumreicher's experience, according to which much ammonia accompanies the hydroxylamine in this reaction, and our own, according to which, under certain conditions, no ammonia at all is produced.

ON A NEW METHOD OF
VOLUMETRIC ANALYSIS APPLICABLE TO THE
ASSAY OF MANGANESE PEROXIDE.

By M. PAUL CHARPENTIER.

THE new method of analysis which I am about to explain, and which is founded upon the use of the alkaline sulphocyanides, avoids certain causes of error or inconveniences presented by the methods of analysis hitherto employed in the assay of peroxide of manganese.

In principle the apparatus which the author adopts comprises a small flask, A, provided with a stopper pierced with two holes. In one is fixed a tube which is closed during the operation, but through which, when it is completed and the flask has become cold, we may pass, by aspiration or by insufflation, a current of air which expels the last traces of chlorine, forcing them to come and fix themselves in the absorbent liquid.

Through the second hole passes a very short tube opening into a bottle, B, with two apertures, containing nothing, but surrounded with cold water. Finally this bottle B is connected by a safety-tube with a flask, C, or a bulb-tube containing the liquid intended to fix the chlorine.

The author recalls the reactions upon which is based the new method forming the subject of this note and those which he indicated more than fifteen years ago for alkalimetric and acidimetric assays, the assays of iron and silver, the determination of nitrogen and of mercury by means of the alkaline sulphocyanides.

1. $3\text{KC}_2\text{NS}_2 + \text{Fe}_2\text{O}_3\text{SO}_3 = \text{Fe}_2(\text{C}_2\text{NS}_2)_3 + \text{KOSO}_3$.
2. $\text{Fe}_2(\text{C}_2\text{NS}_2)_3 + 3\text{KOH} = \text{Fe}_2\text{O}_3 + 3\text{KC}_2\text{NS}_2 + 3\text{HO}$.

3. $\text{KOH} + \text{Fe}_2\text{O}_3 + 4\text{SO}_3\text{HO} =$
 $= \text{KOSO}_3 + 5\text{HO} + \text{Fe}_2\text{O}_3\text{SO}_3$.
4. $\text{Fe}_2\text{O}_3\text{SO}_3 + 3\text{KC}_2\text{NS}_2 = \text{Fe}_2(\text{C}_2\text{NS}_2)_3 + 3\text{KOSO}_3$.
5. $\text{AgONO}_3 + 2(\text{Fe}_2\text{O}_3\text{NO}_5) + \text{KC}_2\text{NS}_2 =$
 $= \text{AgC}_2\text{NS}_2 + \text{KONO}_5 + 2(\text{Fe}_2\text{O}_3\text{NO}_5)$.
6. $\text{Fe}_2\text{O}_3\text{NO}_5 + 3\text{KC}_2\text{NS}_2 = \text{Fe}_2(\text{C}_2\text{NS}_2)_3 + 3\text{KONO}_5$.
7. $6(\text{FeOSO}_3 + 7\text{HO}) + 3\text{Cl} =$
 $= \text{Fe}_2\text{Cl}_3 + 2(\text{Fe}_2\text{O}_3\text{SO}_3) + 32\text{HO}$.

We may now apply the method in two different manners, either by the peroxidation of iron or by the determination of silver. In both cases we suppose the use of potassium sulphocyanide.

First Method—The reactions utilised are Nos. 1, 2, and 7. A burette is used graduated into tenths of a c.c. A standard solution of potash is prepared such that one division of the burette corresponds to the precipitation of 0.005 grm. of iron. Calculation shows that for this purpose we must dissolve 150 grms. of pure caustic potash in 1 litre of distilled water. We then treat 1 grm. of manganese peroxide with hydrochloric acid in the ordinary manner in the flask A. If the peroxide were pure it would give off 0.8161 grms. chlorine, which at 0° and 760 m.m. pressure would occupy 0.2574 litre. The bottle B arrests and condenses any vapours of hydrochloric acid which might, for want of precaution, be evolved along with the chlorine. We collect the chlorine in the vessel C, which contains, for instance, 1 litre of water holding in solution 10 grms. ferrous sulphate very pure. The chlorine evolved by 1 grm. pure per oxide marking 100 chlorometric degrees can peroxidise 6.391 grms. of sulphate.

When the operation is completed and the chlorine expelled from A and B, we add to the ferroso-ferric solution a small quantity of ammonium chloride and then potassium sulphocyanide, which produces the usual blood-red colour. We then add the standard solution of potash until it is decolourised. The number N of divisions employed indicates at once the volume of chlorine in c.c.'s which 1 grm. of the oxide under examination can evolve. We have then a table in two columns, the first containing the values of N and the second that of the corresponding chlorometric degrees D.

N.	D.
258.00	100.12
129.00	50.06
257.7	100.00
128.85	50.00

Second Method.—Here we utilise the reactions 5 and 6. We know that the weight of pure peroxide necessary to evolve 1 litre of chlorine at 0° and 760 m.m. pressure is exactly equal to $3.17 \times \frac{43.5}{35.5} = 3.884$ grms. We operate

therefore upon 3.884 grms. of peroxide and we collect the chlorine in 1 litre water containing 15.180 grms. of pure crystalline silver nitrate. We then add a drop of ferric nitrate and pour in the standard solution of potassium sulphocyanide prepared in such a manner that 500 divisions precipitate 15.180 grms. silver nitrate. If the oxide is pure all the silver will be precipitated by the chlorine; a drop of sulphocyanide causes the red tint to appear immediately. If the peroxide evolved no chlorine at all we should have to pour in 500 divisions before the colour appears. The zero of the burette therefore corresponds to the chlorometric degree 100. The number *n* of divisions run in will indicate directly the chlorometric degree according to the following table.

<i>n</i> .	Degrees <i>d</i> .
0	100°
250	50°
500	0°

We remark that the values *d* which gives the hundredths of a litre of chlorine obtained indicate equally the per cents of pure manganese contained in the sample.

These two methods are rapid and accurate. Their principal advantage is due to the extreme sensitiveness of the reaction, which is such that the presence of 1-3,000,000th can be distinguished.—*Comptes Rendus*, ci., p. 316.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,

Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from p. 79).

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
|| Following a date signifies publication discontinued.

109. JOURNAL DER PHYSIK. Herausgegeben von Fr. Albrecht Carl Gren. 8 vols., 8vo. Halle und Leipzig, 1790-'94.

Continued under the title:

- [a] Neues Journal der Physik. Herausgegeben von Fr. Albrecht Carl Gren. 4 vols. (I.-IV.), 8vo. Halle und Leipzig, 1794-'98.

Continued under the title:

- [b] Annalen der Physik. Anfangen von Fr. Albr. Carl Gren, fortgesetzt von Ludwig Wilhelm Gilbert. [From vol. iv., Herausgegeben von Ludwig Wilhelm Gilbert.] 30 vols. (I.-xxx.). 8vo. Halle, 1799-1808. Neue Folge. 30 vols. (I.-xxx. and xxxi.-lx), 8vo. Halle, 1809-'18.

Supplement zu Band xii. 1803.

Continued under the title:

- [c] Annalen der Physik und der physikalischen Chemie. Herausgegeben von Ludwig Wilhelm Gilbert. Dritte Reihe. 16 vols. (I.-xvi. and lxi.-xxxvi.), 8vo. Halle, 1819-'24. Vol. lxi., 1819, is also entitled: *Neueste Folge*.

Continued under the title:

- [d] Annalen der Physik und Chemie. Herausgegeben von Julius C. Poggendorff. 30 vols., (I.-xxx. and lxxvii.-cvi), 8vo. Berlin, 1824-'33.
Zweite Reihe. 30 vols. (I.-xxx. and cvii.-cxxxvi.), 1824-'45.
Dritte Reihe. 30 vols. (I.-xxx. and cxxxvii.-clxvi.), 1844-'53.
Vierte Reihe. 30 vols., (I.-xxx. and clxvii.-cxcvi.), 1854-'63.
Fünfte Reihe. 30 vols. (I.-xxx. and cxcvii.-ccxxvi.), 1864-'73.
Sechste Reihe. 10 vols. (I.-x. and ccxxvii.-ccxxxvi.), 1874-'77.

Continued under the title:

- [e] Annalen der Physik und Chemie. Neue Folge. Unter Mitwirkung der physikalischen Gesellschaft in Berlin und insbesondere des Herrn H. Helmholtz. Herausgegeben von G. Wiedemann. 23 vols. (I.-xxiii. and ccxxxvii.-cclix.), 8vo. Leipzig, 1877-'84+
Ergänzungs-Bände: Bd. I., 1843; II., 1848; III., 1853; IV., 1854; V., 1871; VI., 1874; Jubelband, 1874.
Indexes: Vols. I.-xxx., 1833; xxxi.-xlii.-1837; xliii.-li., 1842, li.-lx., 1844; lxi.-lxix., 1846; lxi.-lxxv., 1848; lxxvi.-lxxxiv., 1851; lxi.-xc., 1854.

Namen-Register zu Band I. bis cl., Ergänzungsband I. bis vi. nebst Jubelband, und Sach-Register zu Band cxxi. bis cl., Ergänzungsband v. and vi. nebst Jubelband, bearbeitet von W. Barentin, nebst einem Anhang von J. C. Poggendorff enthaltend Verzeichniss der verstorbenen Autoren, und Zeitafel zu den Bänden. 8vo. Leipzig, 1875.

From 1877 the Annalen are accompanied by:

- [f] Beiblätter zu den Annalen der Physik und Chemie. Herausgegeben unter Mitwirkung befreundeter Physiker von J. C. Poggendorff. 8 vols., 8vo, Leipzig, 1877-'84+

JOURNAL DER RUSSISCHEN PHYSISCH-CHEMISCHEN GESELLSCHAFT. See Zhurnal russkova khimicheskova [etc.].

110. JOURNAL FÜR PHYSIK UND PHYSIKALISCHE CHEMIE DES AUSLANDES. In vollständigen Uebersetzungen, herausgegeben von A. Krönig. 3 vols., 8vo. Berlin, 1851.||

JOURNAL FÜR PRAKTISCHE CHEMIE. See Allgemeines Journal der Chemie.

JOURNAL FÜR DIE CHEMIE, PHYSIK [etc.]. See Allgemeines Journal der Chemie [b].

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(To be continued).

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

THE BIOLOGICAL EXAMINATION OF WATER.

By C. J. H. WARDEN, Surg. H.M.'s Bengal Army,
Professor of Chemistry, Calcutta Medical College.

(Continued from p. 76.)

It may be of interest to append the appearances presented by the cholera and typhoid bacillus when cultivated in different media. Dr. Koch found the cholera bacillus in the water of certain tanks in India: he also found in one sample a bacillus, which, while agreeing in morphological characters with the cholera bacillus, proved on cultivation not to be that organism. The necessity, therefore, of not assuming on morphological characters alone that every comma-shaped bacillus is the cholera bacillus must be kept in view.

Cholera Bacillus; Growth on Plates.—At a very early stage the colonies appear as very pale and tiny drops, which are not quite circular, and present a granulated appearance. As a colony grows the granulated appearance becomes more evident, and it looks like a mass of refracting granules. At a later stage the gelatin liquefies in the immediate neighbourhood of the colony, and it sinks into the gelatin. A funnel-shaped cavity is thus formed, and at the apex a small whitish spot is seen. The gelatin liquefies very slowly. During the growth of the colonies a peculiar odour is slowly developed, which is not unlike the smell of a fresh cholera intestine.

Growth in Test-tubes.—As soon as the cultivation commences to develop a small funnel-shaped cavity is formed, which marks the site of inoculation. By degrees the gelatin liquefies in the neighbourhood of this point of inoculation, and the colony extends along the track of the inoculating needle. But there is always a deep spot, sunken at the top, and the border of the funnel-shaped cavity is always formed by a ring of solid gelatin. Three strata may be distinguished in this funnel-shaped cavity: an upper turbid layer, containing active bacilli; a middle translucent or nearly clear layer; while the apex of the funnel is occupied by a loosely-packed white *débris*. At temperatures from 17° to 19° C. growth is very slow.

Growth on Potatoes.—There is little or no growth at a temperature from 17° to 19° C. At a temperature, however, of 30° C., after some days, small brownish colonies appear, but always in thin layers.

Growth in Cupped-slides with Bouillon.—The cholera bacillus exhibits rapid motion, and at a high temperature there is a large development of spirilla, which are not simple wavy threads, but very tender long spirals, which move in an animated manner.

Morphological Characters.—The cholera bacillus is about half, or at most two-thirds, as long as a tubercle bacillus, but much more bulky, thicker, and slightly curved. Curve generally not more marked than that of a comma, but may be semi-circular, or curve may be double, like a letter S.

As regards the detection of the typhoid bacillus in water, Dr. Gaffky informs me that the examination of several specimens supposed to have been contaminated with typhoid dejecta, led in no single instance to a positive result. This is, however, no reason why the search should be abandoned. Scientifically it would be of the highest interest to be able to demonstrate the presence of the typhoid microbe in a medium which is so frequently credited with conveying the disease.

Typhoid Bacillus; Growth on Plates.—Small yellowish brown colonies in the interior of the gelatin, which attain their maximum growth in from four to eight days, and then do not increase in size, and which do not cause liquefaction of the gelatin. On examination the colonies appear somewhat granular, roundish, and as if filled with densely interlaced fibres, which come to the surface, grow on it, but do not extend any distance round the borders of the colony.

Growth in Test-tubes.—The bacilli grow along the

track of inoculation, but not very luxuriantly; appear on, and form a thin layer over, the whole surface of the gelatin. Do not liquefy the gelatin.

Growth on Potatoes.—After two or three days at ordinary temperatures, no appearance of growth to naked eye; on microscopic examination, however, the whole surface of the potato is found covered with more or less actively mobile bacilli. Below 20° C. no spores are found, but at 30°—42° C. spores develop after three or four days. The spores are round at the ends, and occupy the entire diameter of a bacillus. Long filaments of jointed bacilli are often developed, in which case the spores are at opposite ends; while at the point of contact of two bacilli, commencing spore formation is visible.

Growth in Cupped-slides.—If inoculated in bouillon from potatoes, the bacilli appear thicker than when seen in the spleen or other organs. Actively mobile, best seen at periphery of the drop, to which the bacilli appear to lie parallel; of different lengths; jointed threads also formed. No spore formation at low temperatures.

Morphological Characters.—In length about one-third the diameter of a red blood cell, and three times as long as broad; ends distinctly rounded. As a rule do not stain well, and very frequently not uniformly, unstained circular spots not extending the whole diameter of a bacillus being left pale. Methyl-violet is perhaps the best stain.

(To be continued.)

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Prof. CHAS. E. MUNROE, U.S.N.A.

(Continued from p. 82.)

DR. C. WILLIAM SIEMENS, in his presidential address before the British Association for the Advancement of Science entitled "Science in Relation to the Arts," says that when the Association met at Southampton on a former occasion, Schonbein announced to the world his discovery of gun-cotton. This discovery has led the way to many valuable researches on explosives generally, in which Mr. Abel has taken a leading part. Recent investigations by him in connection with Captain Noble, upon the explosive action of gun-cotton and gunpowder confined in a strong chamber (which have not yet been published), deserve particular attention. They show that while by the method of investigation pursued about twenty years ago by Karolyi (of exploding gunpowder in very small charges in shells confined within a large shell partially exhausted of air) the composition of the gaseous products was found to be complicated and liable to variation, the chemical metamorphosis which gun-cotton sustains, when exploded under conditions such as obtained in its practical application, is simple and very uniform. Among other interesting points noticed in this direction was the fact that, as in the case of gunpowder, the proportion of carbonic acid increases while that of carbonic oxide diminishes with the density of the charge. The explosion of gun-cotton, whether in the form of wool, or in the form of loosely spun thread, or in the packed compressed form devised by Abel, furnished practically the same results if fired under pressure, that is, under strong confinement—the conditions being favourable to the full development of its explosive force; but some marked differences in the composition of the products of metamorphoses were observed where gun-cotton was fired by detonation. With regard to the tension exerted by the products of explosion, some interesting points were observed, which introduce very considerable difficulties into the investigation of the action

* From the *Proceedings of the U.S. Naval Institute*.

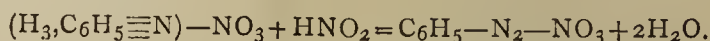
As it is proposed to continue these notes from time to time, authors, publishers, and manufacturers will do the writer a favour by sending him copies of their papers, publications, trade circulars, or expert testimony in infringement cases.

of fired gun-cotton. Thus, whereas no marked differences are observed in the tension developed by small charges and by very much larger charges of gunpowder having the same density (*i.e.*, occupying the same volume relatively to the entire space in which they are exploded), the reverse is the case with respect to gun-cotton. Under similar conditions in regard to density of charge, 100 grms. of gun-cotton gave a measured tension of about 20 tons on the sq. inch, 1500 grms. gave a tension of about 29 tons (in several very concordant observations), while a charge of 2.5 kilos. gave a pressure of about 45 tons, this being the maximum measured tension obtained with a charge of gunpowder of five times the density of the above.

The extreme violence of the explosion of gun-cotton as compared with gun-powder when fired in a closed space was a feature attended with formidable difficulties. In whatever way the charge was arranged in the firing cylinder, if it had free access to the enclosed crusher gauge, the pressures recorded by the latter were always much greater than when means were taken to prevent the wave of matter suddenly set in motion from acting directly upon the gauge. The abnormal wave pressures recorded at the same time that the general tension in the cylinder was measured, amounted in the experiment to 42.3 tons, where the general tension was recorded at 20 tons; and in another where the pressure was measured at 29 tons, the wave pressure recorded was 44 tons. Measurements of the temperature of explosion of gun-cotton showed it to be about double that of the explosion of gunpowder. One of the effects observed to be produced by this sudden enormous development of heat was the covering of the inner surfaces of the steel explosion-vessel with a network of cracks, small portions of the surface being sometimes actually fractured. The explosion of charges of gun-cotton up to 2.5 kilos. in perfectly closed chambers, with development of pressures approaching to 50 tons on the square inch, constitutes alone a perfectly novel feat in investigations of this class. Messrs. Noble and Abel are also continuing their researches upon fired gunpowder, being at present occupied with an inquiry into the influence exerted upon the chemical metamorphosis and ballistic effects of fired gunpowder by variation in its composition, their attention being directed especially to the discovery of the cause of the more or less considerable erosion of the interior surface of guns produced by the exploding charge—an effect which, notwithstanding the application of devices in the building up of the charge specially directed to the preservation of the gun's bore, has become so serious that, with the enormous charges now used in our heavy guns, the erosive action on the surface of the bore produced by a single round is distinctly perceptible. As there appeared to be *prima facie* reasons why the erosive action of powder upon the surface of the bore at the high temperatures developed should be at any rate in part due to its one component sulphur, Noble and Abel have made experiments with powders of usual composition and with others in which the proportion of sulphur was considerably increased, the extent of erosive action of the products escaping from the explosion-vessel under high tension being carefully determined. With small charges a particular powder containing no sulphur was found to exert very little erosive action as compared with ordinary cannon powder; but another powder containing the maximum proportion of sulphur tried (15 per cent) was found equal to it under these conditions and exerted very decidedly less erosive action than it, when larger charges were reached. Other important contributions to our knowledge of the action of fired gunpowder in guns, as well as decided improvements in the gunpowder manufactured for the very heavy ordnance of the present day, may be expected to result from a continuance of these investigations. Professor Carl Himly, of Kiel, having been engaged upon investigations of a similar nature, has lately proposed a gunpowder in which hydrocarbons precipitated from solutions in naphtha take the place of the charcoal and sulphur of ordinary powder. This powder has

amongst others the peculiar property of completely resisting the action of water, so that the old caution "keep your powder dry," may hereafter be unnecessary.—(*Four. Frank. Inst.*, cxv., 687, 215, March, 1883.)

All of the explosive substances in common use are believed to owe their explosive properties to the fact that they contain nitrogen which exists wholly or in part in the body, united with oxygen, in the form of nitryl, NO_2 . There is yet another class of nitrogenised bodies, some of which are explosive, which may be regarded as formed by the replacement of two atoms of hydrogen (in two molecules of an aromatic hydrocarbon) by two atoms of nitrogen. A body so constituted is called an *azo* compound. Diazobenzene, $\text{C}_6\text{H}_5-\text{N} \equiv \text{N}-\text{C}_6\text{H}_5$, which may be formed by the indirect substitution of hydrogen by nitrogen in benzene, is a type of this class. It stands intermediate in composition between nitrobenzene and aniline. Diazobenzene is a quite unstable substance, while the nitrate is a crystalline solid, which is employed in the arts for the manufacture of dye-stuffs, and which is so explosive that it has been proposed for use as a detonating primer. It may be formed by the action of nitrous acid on phenyl-ammonium nitrate according to the reaction—



Berthelot and Vieille have made a study of the properties of diazobenzene nitrate (*Annales de Chimie et de Physique* [5] xxvii., 194, Oct., 1882), and they consider it as representing the residue of two nitrogenised bodies which have lost, the one (nitrous acid) its oxygen, the other (aniline) a part of its hydrogen, in the action of combination; but a notable portion of the energy of these elements remains in the residue, which accounts for its explosive character. They have examined this substance in the same way as they have done for fulminating mercury.* If preserved in dry air out of contact with the light it can be kept for two months and more, but exposed to daylight it slowly changes: in moist air the change is rapid, and in contact with water it is decomposed immediately. It is as sensitive to a blow as mercuric fulminate. On heating it detonates with extreme violence at about 90° , while mercuric fulminate detonates at about 195° . Slowly heated at a lower temperature it slowly decomposes. Its density is 1.37. Total heat of combustion under constant volume +783.9 cal., and under constant pressure +782.9 cal.; heat of formation -89 cal., showing it to be an endothermic substance like the other high explosives. The heat of combustion was determined by burning in oxygen; so the heat formed during detonation, pure and simple, was also measured and was found to be +114.8 cal. per equivalent, or 687.7 cal. per kilo. The volume of the gases produced was 817.8 litres per kilo., or 136.6 litres per equivalent consisting of—

HCN..	..	3.2	and for 136.6 litres	4.4
CO ..	..	48.65		66.4
CH ₄ ..	..	2.15		2.9
H ..	..	27.7		37.9
N ..	..	18.3		25.0
		100.00		136.6

We notice in the reaction that a considerable quantity of hydrocyanic acid results; that the oxygen all unites to form carbon protoxide, no water being formed; three-fourths of the nitrogen is liberated in the free state, and a fifth in the state of hydrocyanic acid. The remainder of the nitrogen is found in the carbonaceous residue, about one-fifth existing as ammonia, and the remainder in a peculiar state of combination with the carbon. Of the five equivalents of hydrogen about three and one-half exist free; a half equivalent forms marsh-gas, a half ammonia and hydrocyanic acid, and about a half is united with the carbon. One-half the carbon forms carbon

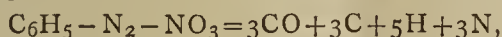
* *Proc. Nav. Inst.*, vol. viii., p. 441.

† *Ibid.*, p. 305.

protoxide, and a ninth of the remainder exists as marsh-gas and hydrocyanic acid. The solid residue contains four-ninths of the carbon. The empirical formula of the residue is $C_5H_2N_2$. It is, then, a carbon rich in hydrogen and nitrogen, probably combined under the form of condensed and polymeric bodies. By calculation the gaseous products contain 75.9 per cent of the weight of the substance; there remains 24.1 per cent of residue in the form of a very voluminous black impalpable powder with an ammoniacal odour. The ammonia in the residue was 0.11 per cent, and in the gas 0.0042 per cent. The following table represents these results in 1000 parts by weight:—

Nitrogen	{ free	189.7	215.6	251.2
	{ as HCN	16.7		
	{ as H ₃ N	9.2		
	{ combined with the carbon	35.6		
Oxygen as CO					287.6
Hydrogen	{ free	20.5	26.9	29.9
	{ as CH ₄	3.2		
	{ as HCN	1.2		
	{ as H ₃ N	2.0		
{ combined with the carbon	3.0			
Carbon	{ as CO	215.8	239.6	431.3
	{ as HCN	14.3		
	{ as CH ₂	9.5		
	{ carbon	191.7		
Summary.				
Gaseous products		769.7	1000.0	
Residue		230.3		

Neglecting the secondary products, the reaction may be written—



but ammonia, marsh-gas, and hydrocyanic acid are formed as secondary products.

The simple decomposition in accordance with the above reaction should liberate +204.7 cals. under constant volume, instead of +114.8 as found. This shows that the secondary products have absorbed -89.9 cals. during their formation. This absorption results chiefly from the formation of the compound of carbon and nitrogen. The exothermic formation of the ammonia and marsh-gas very nearly compensates for the endothermic formation of the hydrocyanic acid. This agrees with the general observation that the hydrocarbons, rich in carbon and carbonaceous matter, retain a notable portion of the energy of the complex bodies from which they are derived. It surpasses in some instances the energy of the elements themselves. This observation, first made by Berthelot on acetylene, is quite generally applicable to pyrogenous decompositions, and serves to explain the singular conditions under which certain endothermic compounds are formed even at the moment when the heat destroys the organic compound.

It remained to determine the tension in a closed vessel. This was determined by the method used for mercuric fulminate, with the following result:—

Density of Charge.	Weight of Charge, grms.	Pressure in kilos. per c.m. ²	Pressure with Mer. Fulminate.
0.1	2.37	990	480
0.2	4.74	2317	1730
0.3	7.11	4581	2700

The pressures for diazobenzene nitrate are greater than those for mercury fulminate for the same density of charge; but, on the contrary, mercuric fulminate will develop a much greater pressure (24,000 kilos. instead of 7500 kilos.) when detonated in its own volume, on account of its greater density. The destructive effects of the two explosives differ, following the density of charge. On contact the effect is much more marked with mercuric fulminate.

The same number of this journal, p. 202, contains an article by Berthelot and Vieille, entitled "Researches on Nitrogen Sulphide." The nitrogen sulphide is formed by

the action of sulphur chloride on ammonia, and is obtained in well-defined crystals having the formula of NS corresponding to nitric oxide. The substance is not affected by dry or moist air, and has been several times heated to 50° without change. It detonates under the hammer, but is less sensitive than diazo-benzene nitrate or mercuric fulminate. It deflagrates at 207°, but more slowly than mercuric fulminate. The pressures developed by the explosion of nitrogen sulphide are very nearly the same as those obtained for mercuric fulminate with a density of 0.2 and 0.3 of charge. But these relations are somewhat uncertain, and cause the very marked difference which exists in the rapidity of decomposition of the two bodies. On account of this the effects produced by the two bodies used as detonators and in fuses ought to be very different.

It is a well-known fact that the intervention of an obstacle in the path of a beam of sound-waves causes the formation of a shadow, but owing to the length of the waves the shadow is not so marked as for light. In 1826 Colladon made experiments which proved that sound shadows are more perfectly defined in water than in air. Prof. John Le Conte has extended these observations, which he publishes in the *Am. Journ. Sci.* [3], xxiii., 27, Jan., 1882, under the title "On Sound Shadows in Water."

The experiments were executed in 1874, during the engineering operations incident to the removal of "Rincon Rock," a sandstone reef in the harbour of San Francisco, by means of "surface blasting" with "giant powder" or dynamite. The depth of water on the reef was about fifteen feet at low tide, with an extreme tidal range of about six feet. The "cans" or "cartridges" of "giant powder" used contained each about fifteen pounds of the explosive compound, comprising about 75 per cent of nitro-glycerin.

It was observed that the suddenness of the shock imparted to the water by this explosive agent produced the most remarkable and astonishing effects. At the distance of 300 feet or more from the detonating cartridge two distinct shocks were experienced. The first shock came through the intervening waters, and was felt as a short concussion or click before there was any sensible elevation of the column of water resting over the point of explosion. The second shock came a little later by the air and was heard. It was evidently communicated to the air by the water, at the time the elastic pulse transmitted by this liquid (the first shock) emerged, in a direction nearly normal to its surface, over a limited area around a point vertically above the exploding cartridge. This was obvious from the fact that aerial sound came from this region. The area, which was the source of the sound transmitted by the air, was the same as that from which the small jets of water (noticed hereafter) were projected. The gases generated during the explosion came to the surface much later than this shock, and after elevating the column of water, over the position of the cartridge, to the height of 25 or 30 feet. It is the character of the first shock that deserves special notice. To a person sitting in a small boat floating on the water at a distance of 300 feet or more from the point of explosion, with his feet resting on its bottom, the shock was felt as a sudden blow applied to the soles of the feet. In fact, it drove out the oakum from the seams in the bottom of the boat. When the observer stood on the top of a vertical wooden pile, this shock was felt as a concussion coming up from the water along the cylinder of wood. The concussion produced by such an explosion was so violent that it killed or stunned the fish in the water within a radius of 200 or 300 feet from the explosive centre. They rose to the surface in a helpless condition, and were easily secured.

In these experiments the observer stood on the top of a vertical cylindrical pile (the trunk of an Oregon pine) about 1 foot in diameter, situated about 40 feet horizontally from the explosive cartridge. A bottle being secured to a rigid rod, was first plunged under the water from 10 to 12 inches behind the pile, that is, within its geometri-

cal shadow. The shock of the explosion did not injure the bottle. It was then plunged into the water in front of the pile, or outside its geometrical shadow. In this position the bottle was shivered to atoms by the concussion due to the explosion. The experiments were varied by plunging bottles into the water in various positions around the pile within and outside of its geometrical projections from the explosive centre; and in all cases they were protected from injury when within the geometrical shadow, and were shivered when outside of the same. The same results took place whether the bottles were filled with water or with air. The breaking of a glass vessel by a sudden shock communicated by means of water is a fact long known, and is illustrated by the old familiar class experiment of exploding a "Prince Rupert drop" while its bulb is plunged into an ordinary phial filled with water.

Cylindrical glass tubes about six feet long and one-fifth inch in diameter, the glass being about 0.5 of an inch in thickness, were also employed. They were covered by pasting cartridge-paper over them, so as to prevent the loss of fragments when breakage occurred. The tubes were adjusted to a framework of wood, so arranged that they could be plunged in a horizontal position beneath the surface of the water behind the pile, the axis of the tube being at right angles to the plane of its shadow, and held there (the observer standing as before on the top) with the middle of the tube in the geometrical shadow, while the extremities projected on either side about 2.5 feet beyond the boundaries of said shadow. In every case the shock of the explosion shivered the projecting portions of the tube, and left the portion within the shadow uninjured. The boundaries between the broken and the protected portions of the glass were sharply defined. By standing on the top of a second pile in the direction of the axis of the shadow of the first pile, and distant about 12 feet, the experiments were varied by plunging the framework and tubes—adjusted at right angles to the plane of the prolonged shadow—into the water at this distance (12 feet) from the obstacle which obstructed the sound-wave transmitted by the liquid. The shock of the explosion produced sensibly the same results as when the tube was near to the obstructing obstacle: the protected portion of the horizontal glass tube was sensibly equal in length to the diameter of the pile casting the shadow. Hence the shadow of the cylindrical pile extended back for about 12 feet between sensibly parallel vertical planes, and its boundaries at this distance were still sharply defined. It is evident that, if the explosive centre were of insensible magnitude, the horizontal thickness of the geometrical shadow of the pile, at a distance of 12 feet beyond it, would be augmented in the ratio of 40 to 40 + 12, or of 40 to 52, these numbers being the distances in feet from the centre. So that if the thickness of the shadow at the pile were 12 inches, its thickness at 12 feet beyond would be 15.6 inches. If, however, the explosive energy occupied more or less space (as was the case in relation to the "giant powder" cartridges), the thickness of the geometrical shadow or umbra cast by the pile might not increase sensibly with augmenting distance, and, indeed, in case the exploding body exceeded 12 inches in diameter, the thickness of the shadow would diminish with increasing distance from the obstructing pile; as in the case of the umbra cast by an opaque body which is smaller than the luminous source. Another interesting phenomenon came under notice during the execution of these experiments. It was the singular effects observed on the surface of the water (when perfectly calm and glassy) for a certain area around the point immediately over the exploding cartridge. Simultaneous with the first shock transmitted by the water—and before the ascending gases of explosion disturbed it—the surface of the liquid exhibited numerous jets of water, rising to the height of about 3 inches over the centre of the area, and diminishing in height with augmenting distance from the centre. The appearance presented was not unlike that produced by a heavy

shower of rain falling on the calm waters of a lake. To an observer in a boat floating on the adjacent water, and consequently viewing the phenomenon from a point near the water-level, there seemed to be a curious quincunx-like arrangement of the jets.

In the case of solitary waves generated by sudden blows and explosions, it is more difficult to form a just estimate of the wave-length than in the case of musical sounds. Nevertheless it is evident that the wave-length must be directly proportional to the time occupied by the displacing impulse multiplied by the velocity of transmission of the elastic pulse. If L = wave-length, t = time of the generating impulse, and v = velocity of sound in the elastic medium, we have L varies as $t \times v$ or $L = t \times v$. Consequently, in a given medium in which v remains constant, L will be a function of t , or the duration of the generative impulse; so that when the factor t is indefinitely small, the value L will be correspondingly small. Hence, when the time of the blow or explosive impulse is exceedingly brief, the wave-length must be proportionately short.

All the phenomena incident to the explosion or detonation of the nitro-glycerin compounds indicate that the impulse generated is of indefinitely brief duration; indeed, its suddenness is almost beyond conception. The efficiency of surface blasting under water by means of these explosive compounds depends upon this extraordinary suddenness of detonation, which renders the effect akin to that of the sudden blow of an enormous unyielding mass. It is evident that the wave generated in an elastic medium like water by an explosion of this character must be very intense and very short. Hence the acoustical shadow produced by an obstacle placed in its path of propagation must, as in the case of light, be sharply defined and definite in its boundaries. Thus, the striking fact that the protecting influence of the piles on the glass vessels plunged in the water was narrowly circumscribed within the limits of the geometrical shadow may be rationally traced to the extreme shortness of the elastic waves, due to the inconceivably brief duration of action of the generative detonations. If the foregoing is the true explanation of the definiteness of the sound shadows cast in the preceding experiments, then the waves generated by the explosion of ordinary gunpowder, being less sudden, should not produce as sharply defined shadows as those due to the detonation of dynamite. We have, so far as known, no specific experiments testing this point, but it seems to be quite reasonable that such will be found to be the case whenever the test of experiment is applied. For it is well known that the subaqueous explosion of ordinary powder does not give rise to the remarkable concussions so characteristic of the detonations of the nitro-glycerin mixtures. Moreover, if this explanation is correct, the acoustical shadows produced by nitro-glycerin detonations in air ought also to be more sharply defined than those due to sounds less suddenly generated. In other words, if the distinctness of sound shadows depends upon the duration of the impulse which produces the accompanying sound wave, then the definiteness of the shadows cast by sounds propagated through the air should vary with the suddenness of the action of the generating cause.

Inasmuch as the variations in the duration of the genesis of audible sounds in the atmosphere must in ordinary experience be very great, it may at first sight appear incredible that the corresponding differences in the perfection of sound shadows cast by obstacles in the paths of different kinds of sounds should have escaped the most casual observation. But it must be recollected that, for the reasons already assigned, aerial acoustical shadows are not readily appreciated by the ear. Moreover, in the case of sounds transmitted by the air, the distinctness of such shadows is most seriously impaired by the numerous reflected waves which come from circumjacent objects. It should be borne in mind that it is only very recently that the influence of acuteness of sounds on the distinctness of the resulting shadows has been very satisfactorily

verified by experiment. In like manner, I venture to predict that careful experiments will verify the deduction that the shadows due to sounds generated by the extraordinarily brief detonations of dynamite are more sharply defined than those owing their origin to sounds less suddenly produced.

In confirmation of the foregoing view the following observation may be cited:—On the 16th of April, 1880, an explosion of about 2000 or 3000 pounds of a nitro-glycerin compound occurred at the "Giant Powder Works," situated under a bluff on the eastern shore of the bay of San Francisco, at a distance (determined by triangulation) of 16,201 feet (4938 metres) in a direct line in a north-west direction from my room in the University building. About twenty-five men were blown to atoms; no one escaping to reveal the cause of the accident. The concussion at the University buildings (more than three miles distant) was sufficient to break about a dozen panes of stout glass on the side next to the explosive centre. Nearly every person about the University grounds experienced two distinct shocks: one transmitted by the air, and the other by the ground. The cottage occupied by my brother was situated in the geometrical shadow of one of the buildings; being about 890 feet on the farther side of it. No aerial shock was experienced by him or any member of the household; and the concussion transmitted by the earth was alone felt as a shock emanating from the floor. In other terms, the acoustical shadows cast by the intervening structure completely cut off the sound-wave coming by the air. It is scarcely necessary to add that for ordinary sounds such would not have been the result. The singular phenomenon observed of numerous small jets projected from the surface of the water when the shock transmitted by the liquid reached the surface area above the exploded cartridge, was probably due to the circumstance that when the short and intense electric wave emerged in a direction normal, or nearly normal, to the aqueous surface, the tense superficial capillary film yielded to the sudden impulse more readily at some points than others. The sensibly homogeneous character of such a tensile elastic film would naturally tend to group the points of rupture, or jets of water, into more or less perfect order, partaking more or less of geometrical symmetry. Hence the curious quincunx-like arrangement of jets as viewed by the observer near the water-level. According to this view the phenomenon in question seems to find its counterpart or analogue in the more or less symmetrical forms produced by the intersection of the lines of rupture, as the result of tensional strains due to the contraction of homogeneous masses during the process of cooling or of desiccation.

Thus the columnar structure of certain igneous rocks seems to be due to the tensile stress of contractions by cooling after solidification supervened; while the analogous structure developed by the desiccation of homogeneous masses of moist clay, mud, or starch, appears to be produced by a similar strain consequent upon shrinkage from loss of moisture. In a similar manner, the tense superficial capillary film of the water when it experiences the sudden molecular impulse due to the emergence of the elastic pulse, is ruptured along lines more or less symmetrically disposed on the surface of the water; and the liquid beneath is projected through these lines or points of least resistance.

(To be continued.)

Derivatives of Taurine.—J. W. James.—The author describes ethyl-aurine, allyl-aurine, phenyl-aurine, dimethyl-aurine, diethyl-aurine, methyl-phenyl-aurine, and other derivatives. He finds that there is no regularity in the solubilities and fusibilities of the above-mentioned taurine-derivatives. — *Journal für Praktische Chemie*, Vol. xxxi., Parts 8 and 9.

NOTICES OF BOOKS.

Spectrum Analysis in its Application to Terrestrial Substances, and the Physical Constitution of the Heavenly Bodies. Familiarly explained by the late Dr. H. SCHELLEN. Translated from the Third Enlarged and Revised German Edition by JANE and CAROLINE LASSELL. Edited, with Notes, by CAPTAIN W. de W. ABNEY, R.E., F.R.S. With numerous Woodcuts, Coloured Plates, and Angström's and Cornu's Maps. Second Edition. London: Longmans, Green, and Co.

THIS goodly volume may give even the outsider an approximate idea of the importance which spectroscopic analysis has already reached, although its possibilities are not yet by any means exhausted. The responsibility for the work is somewhat complicated. There is, in the first place, Dr. Schellen, the original author; there is Dr. Huggins, whose notes to a former English version were so highly appreciated by Dr. Schellen that he incorporated them in the text of the last German edition; there is Dr. H. J. Klein, who assisted in the completion of the work, which the author's fatal illness prevented him from completing; there are the translators, the Misses Jane and Caroline Lassell; and there is lastly, though not least, the editor, Captain Abney, "by whom the whole has been revised and somewhat remodelled," and certain passages, enclosed in brackets, have been added, to bring the work as near as possible up to date. Certain portions of the earlier editions, which have now become unnecessary or obsolete, have further been expunged. But though the treatise thus assumes somewhat of a co-operative character, it is not on that account the less valuable. We are not acquainted with any work in the English language which gives so comprehensive a survey of spectroscopic apparatus, manipulations, and results.

The first part is devoted to the artificial sources of high degrees of heat and light, including the Bunsen burner, the oxy-hydrogen flame, the electric spark, the induction-coil, and the voltaic arc.

The second part discusses spectrum analysis in its application to terrestrial substances. This section includes certain matter, explanatory and preliminary, such as the refraction of light, refraction through glass with parallel surfaces, refraction of mono-chromatic light by a prism, the dispersion of light, &c. Here follow, also, descriptions of the principal modifications of the spectroscope. Lastly, is an account of the application of the spectroscope to the supervision of the Bessemer conversion process. Concerning the uses of this instrument in the recognition of dyes, &c., very little is said. Indeed, terrestrial spectroscopy, especially as regards organic compounds, scarcely seems to be treated with a thoroughness at all proportionate to that which we recognise in the succeeding chapters devoted to celestial chemistry. This is the more to be regretted, since a summary of the results reached by the use of the spectroscope in qualitative and quantitative analysis would have been decidedly in place in a work like the present. Absorption-spectra and micro-spectroscopy are very briefly touched upon.

The following parts of the work, comprehending the astronomical uses of the spectroscope, are exceedingly elaborate. We have first an account of spectrum analysis as applied to the sun. In this chapter we find matter introduced which, though useful to the celestial spectroscopist, has been discovered by other means of research. Thus we have a paragraph on the telescopic appearance of the solar surface, and speculations as to the nature of the sun-spots founded upon telescopic observations. In short, this chapter may be regarded as a very able account of our knowledge of the physics and chemistry of the sun as obtained, not by the spectroscope alone, but by all the means of research at our command.

The fourth part treats—of necessity much more briefly

—of the investigation of the moon and the planets by spectrum analysis. Here we find descriptions and figures of Merz's object-glass spectroscopic, of Huggins's stellar spectroscopic, of Secchi's large tele-spectroscope, of Huggins's tele-spectroscope, Schröder's spectrum apparatus attached to the Bothcamp reflector, Merz's simple and compound spectroscopic, Browning's miniature spectroscopic, Vogel's stellar spectroscopic, Zöllner's spectroscopic, and Von Konkolly's universal spectroscopic. The results of the examination of the planets and satellites are next given. As regards our moon, no indications of vapour have been detected in her atmosphere,—if, indeed, she can be said to have one.

The fifth chapter describes the application of spectrum analysis to the fixed stars. According to all modern observers Sirius is described as shining with a white light, and as being consequently a type of the first class of stars, which are in the most intense stage of ignition. Yet certain writers of classical antiquity speak of this star as having a *red* light. Is this inaccurate observation on their part, or an instance of defective colour nomenclature? or has this star once burned with a red light—and consequently at a lower temperature—and have its light and heat been since re-intensified? We should require very clear and cogent evidence before admitting the last supposition.

Part sixth discusses the results of the spectroscopic investigation of nebulae and clusters. As regards this very difficult subject it is highly interesting to find that the revelations of the spectroscopic and of the telescope are in accordance.

Part seven is devoted to the results of the spectroscopic examination of comets and meteors, while the eighth and last chapter treats of the spectra of the zodiacal light, of the aurora and of lightning.

There are, further, several appendices on refraction of light through a prism; on the dispersion of light; the indices of refraction for various substances; on the measurement of the wave-lengths of the different coloured rays; on the adjustment of the spectroscopic; Bunsen's maps; measurements of wave-lengths of the Fraunhofer lines; Thalén's table of the wave-lengths of the bright metallic lines in ten-millionths of a millimetre; tables of the bright lines occurring in the spectra of the principal non-metallic elements; the relative intensities of the dark and bright lines; Lockyer's table of the coincidence of the Fraunhofer lines with the lines of metals.

The work is abundantly and admirably illustrated. In addition to the diagrams introduced in the text there are fourteen plates and maps, including Angstrom's maps of the solar spectrum, Cornu's map of the ultra-violet portion of the solar spectrum, Huggins's photographic spectra of the fixed stars, and a map of emission- and absorption-spectra in colours.

To all workers in celestial chemistry and physics this volume will be invaluable.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 4, July 27, 1885.

Isomerism in the Aromatic Series: the Oxybenzoic Acids and their Formation- and Transformation-heats.—MM. Berthelot and Werner.—The reciprocal transformation of isomers of the same chemical function gives rise only to feeble thermic effects, and consequently to a work which is very small, relatively, to that corres-

ponding to combinations properly so-called, to polymerisations, and changes of real function.

Reciprocal Transformation of the Two Varieties of Sulphur, the Prismatic and Octahedral.—D. Gernez.—A reply to the reclamation of priority raised by M. Van't Hoff on behalf of MM. Reicher and Ruys (*Comptes Rendus*, c., p. 1539).

New Method of Volumetric Analysis applicable to the Assay of Manganese Peroxide.—Paul Charpentier.—See p. 87.

Formation-heat of the Alkaline Alcoholates.—M. de Forcrand.—A thermo-chemical paper, not susceptible of useful abstraction.

On Iron Peptonate.—Maurice Robin.—The author remarks that in this preparation the iron is masked by the presence of glycerin if this is added beforehand.

Three New Compounds of Rhodium.—Camille Vincent.—The author has obtained and examined three new organic rhodium compounds, mono-, di-, and trimethyl-ammonium chloro-rhodates. The first of these forms long slender prisms of a deep garnet red. They are anhydrous and undergo no change at 140° C. The di-compound forms large, dark garnet-red prisms, which contain 3H₂O, and effervesce when dried. The trimethyl ammonium compounds are also of a garnet-red colour, but are very readily soluble in water and are very quickly decomposed.

Journal für Praktische Chemie.
New Series, Vol. xxxi., Parts 8 and 9.

Researches on the Refractive Power of Chemical Compounds.—J. Kanonnikoff.—We are led to the opinion that the transition of a chemical compound from one state of aggregation to another does not determine a change in its refractive power. Consequently the refractive power of any given substance is a constant depending merely on the number of the constituents and the manner in which they are combined—simply, as in the haloid acids and the hydrocarbons of the formula C_nH_{2n}+2, or in a complex manner as in the unsaturated organic compounds.

Certain Derivatives of Kyanmethin.—Paul Keller.—The author's results may be summarised as follows:—Kyanmethin, like kyanethin, contains an atom of nitrogen combined as amide with two atoms of hydrogen, as is proved by its behaviour with nitrous acid and phenyl cyanate. Bromo-kyanmethin is formed at once by shaking up a solution of kyanmethin with bromine, whilst to obtain bromo-kyanethin it is necessary to heat kyanethin and bromine together for some hours in a closed tube. In bromo-kyanmethin the bromine is in a very stable state of combination, whilst in bromo-kyanethin it can be easily replaced by other radicles. With chlorine, kyanmethine yields a chlor-kyanmethin dichloride. Kyanethin, similarly treated, yields trichlor-kyanethin. If both the chlorine compounds are treated in the same manner with nitrous acid, chloro-kyanmethin dichloride yields the nitrate of a monochlor-oxy-base of kyanmethin, whilst whilst trichlor-kyanethin yields the corresponding trichlor-oxy-base. Hence it may be inferred that the chemical constitution of kyanmethine is different from that of kyanethin. This difference is a fresh proof how deceitful analogical conclusions may be.

Meta-nitro-amygdalic Acid in Certain Derivatives of Amygdalic Acid.—Carl Beyer.—The author has endeavoured, but unsuccessfully, to furnish a direct proof for the view the dioxindol is the internal anhydride of the amido-amygdalic acid.

Kolbe's Synthesis of Salicylic Acid.—R. Schmitt.—Absolutely dry phenol sodium is introduced into an autoclave, and rather more carbonic anhydride is pumped in than is required for forming sodium carbo-phenylate. The autoclave is then closed, agitated from time to time,

keeping the apparatus refrigerated. The closed autoclave is then heated to 120° to 130° in order to transform the sodium phenyl-carbonate into monosodium salicylate. In this process only half as much sodium hydroxide and phenol are used to produce a given quantity of salicylic acid, as in Kolbe's synthesis.

Preparation of Ethylen-chloro-sulphocyanide, and β-Chloro-propionic Acid.—J. W. James.—The author effects the preparation of the former compound more advantageously by distillation.

Precipitation of Silver Chloride, Bromide, and Iodide from Solutions containing Antimony Oxide and Tartaric Acid.—R. Schneider.—From the author's experiments it appears proved that if any of the halogens has to be precipitated by means of a solution of silver from a liquid containing, at the same time, antimony and tartaric acid, if the solution is sufficiently dilute, and if the excess of silver is minimised, deposits are obtained in which a silver antimony tartrate is not contained in demonstrable quantity.

Fractionated Distillation in a Current of Steam.—F. Rasinski.—A preliminary notice.

On Ferrocyanides.—A. Etard and G. Bémont.—From the *Comptes Rendus*.

Compounds of Arsenious and Arsenic Acids.—A. Joly.—From the *Comptes Rendus*.

Moniteur Scientifique, Quesneville.
Vol. xv., July, 1885.

The Absorption of Atmospheric Nitrogen by Plants.—O. H. Atwater.—Translated from the *American Chemical Journal*.

Cocaine Hydrochlorate.—Dr. Squibb.—From the *Pharmaceutical Journal*.

The Presence of Oxygen in Metals and their Alloys.—A. Ledebur.—The author examines in what state does the oxygen penetrate into melted metals. In those—such as silver—where the affinity for oxygen is small, and where it diminishes as the temperature rises, so that the oxides of the metal are dissociated below the melting-point, he considers that the oxygen is simply dissolved in the melted metal and escapes when the metal begins to solidify. Hydrogen is occluded in the same manner by silver and iron and sulphurous acid by copper. A simple solution of oxygen cannot thus be admitted in the case of metals whose oxides are not dissociated at high temperatures. In such cases we must admit that the oxygen is chemically combined with the metal, forming an oxide which dissolves in the excess of the metal. It seems evident that the oxygen formed under such circumstances is the least oxidised compound which the metal is capable of forming. In case of copper this must be the cuprous oxide, and in case of iron and nickel the ferrous or respectively the nickelous oxide. Oxygen thus fixed in a metal profoundly modifies its properties. As the dissolved oxygen escapes at the moment of solidification it is impossible, in consequence of the spitting, to obtain a dense, homogeneous metal free from air-holes. The more rapid the escape of the oxygen the more marked are these effects. Hence the oxygen dissolved in silver is more injurious than the hydrogen dissolved in cast-iron, whence it escapes gradually. If we alloy with a metal which dissolves oxygen another metal which forms with this a stable chemical compound we may suppress, or at least diminish, the spitting.

Dry Distillation of Wood.—M. Senff.—It appears from the author's experiments that the yield of crude pyroligneous acid, tar, charcoal, and gas is almost the same with the most different woods. But the richness of the acid waters in acetic acid and consequently the yield of dehydrated acid vary greatly. In this respect the wood of coniferous trees is the least valuable. The wood of the

trunk furnishes more acid than that of the branches. The wood yields more acid than the bark, and sound wood more than dead wood. Rapid calcination yields more gas at the expense of the condensed products and of the charcoal; it yields also the weakest acid waters, and the charcoal is more hygroscopic than that furnished by a gradual action.

NOTES AND QUERIES.

* * Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Cement for Setting Stone.—Could any of your readers give or recommend a simple recipe for a cement (to fill half-inch cracks downwards) that will set stone hard, and resist the action of *hydrochloric* and nitric acids—hot or cold? Vulcanite is not a success, and sulphur is very questionable—we avoid that; lead spoils acids.—D.Y.C.

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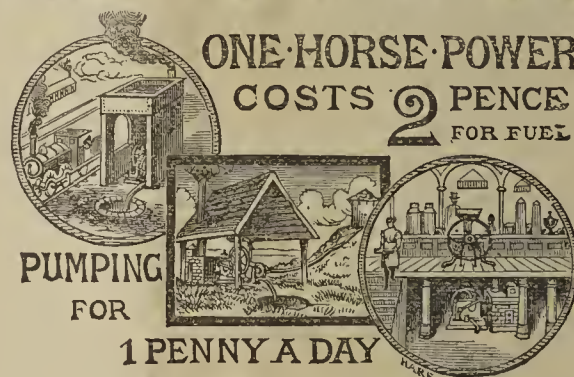
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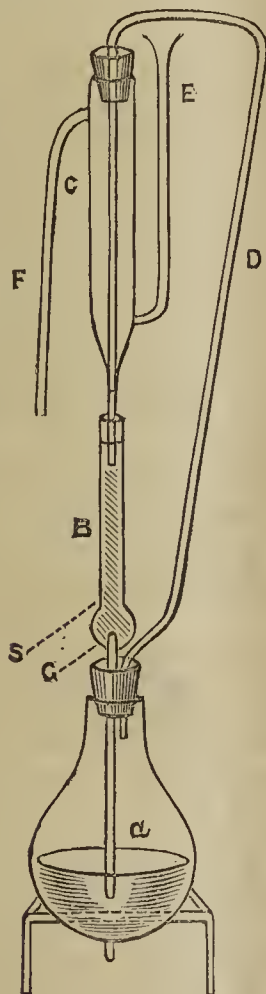
VOL. LII. No. 1344.

NOTE ON THE ACTION OF LIME ON QUININE.

By A. R. HASLAM.

THE question whether the lime employed in the usual process for quinine testing exerts an injurious effect on the yield of the alkaloid is one of considerable importance and interest. If it is a fact that it does so, it throws great doubt on the accuracy of the method, and would of course be a grave source of error.

My attention was first drawn to the subject by an interesting paper written by M. Masse, and published in the March number of the *Journal de Pharmacie et de Chemie*, in which he makes the statement, supported by experiment, that quinine is decomposed by lime at the tempera-



ture of the water-bath or 100° C. Subsequently Mr. Passmore read a paper at a meeting of the Pharmaceutical Society of Great Britain, which was afterwards published in the *Pharmaceutical Journal* and in the *American Journal of Pharmacy*. In this paper he controverts the experiments, and opinion derived from them, by M. Masse, and states that lime has no action on quinine; this view was also held by Prof. Fresenius in 1883. Seeing, therefore, that the subject was still unsettled, I determined to undertake a more extended series of experiments than either of the previous investigators.

M. Masse, in his experiments, found that on taking a known quantity of quinine, and dissolving it in hydrochloric acid, and treating it in the usual way with lime, evaporating it then to dryness, and extracting the quinine

from the residue with ether or chloroform, there was a considerable loss evident in the amount of alkaloid obtained. Mr. Passmore repeated these experiments, but could find no loss exceeding a few milligrams in weight, and which he considers to be due to errors of experiment,

In my investigation I proceeded in the following manner:—4 grms. of the best obtainable sulphate of quinine, containing 12.85 per cent of moisture, and thus equal to 3.48 of pure anhydrous sulphate, was dissolved in 100 c.c. of a 2 per cent solution of hydrochloric acid. The solution was then divided into ten portions of 10 c.c. each. To these portions, containing 0.348 of sulphate of quinine, 5 grms. of hydrate of lime were added, and five of the solutions thus prepared were evaporated to dryness in a hot-water oven, the remaining five being allowed to dry spontaneously over sulphuric acid. I then extracted the quinine from the carefully powdered residue with ether in an apparatus of the form represented in the figure, and which, though not original in principle, has several new and important modifications, which render it much more convenient and efficient than other extraction apparatus in use. The residue is placed in the tube B, a small plug of asbestos preventing it falling, or being carried into, the flask, a, which holds the ether. On warming the flask the ether rises by the tube D into the inverted Liebig's condenser, C, where it is cooled and percolates through the residue, carrying with it the quinine into the flask. When the lime was completely exhausted, the flask which had been previously weighed was disconnected from the apparatus; the ether was then evaporated, and the increase in weight gave the amount of quinine.

In all the five experiments in which heat was employed I found a considerable difference in the quantity of alkaloid found and that which should theoretically be the yield, and which, though never in my experience exceeding 6 per cent, which is considerably below that obtained by M. Masse, is yet sufficient to confirm his opinion. The following table exhibits the results of my experiments:—

	Loss. Heated to 100° C.	Loss. No heat used.
1.	0.018	0.001
2.	0.016	0.004
3.	0.021	0.002
4.	0.021	0.002
5.	0.017	0.001
Average loss — 0.018		— 0.001
Average loss per cent, 5.1.		

It would also appear that lime decomposes quinine at a much lower temperature than 100° C., as 1 gm. of sulphate, when exposed for four hours to a temperature of 70° C., and then evaporated to dryness over sulphuric acid, was found to have lost 0.032, or 3.2 per cent.

August 18, 1885.

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Prof. CHAS. E. MUNROE, U.S.N.A.

(Continued from p. 93.)

IN connection with the foregoing the observations of Gen. Abbot ("Report on Submarine Mines," p. 41) may prove interesting. Thus he states that:—

Before proceeding to discuss mathematically the action of the forces developed by explosions under water, a brief abstract will be given of notes relating to what is usually heard, felt, and seen in the vicinity. The sound is deadened to a surprising degree by water over the charge. A large torpedo exploded 10 feet or more below the surface gives

* From the *Proceedings of the U.S. Naval Institute*.

As it is proposed to continue these notes from time to time, authors, publishers, and manufacturers will do the writer a favour by sending him copies of their papers, publications, trade circulars, or expert testimony in infringement cases.

a dull muffled report that often is hardly noticed by one intently watching the jet. When the water covering is so thin as to allow the gas instantly to escape into the air, the sound is far more intense. Thus one pound of dynamite exploded three feet below the surface produces locally a much louder sound than 500 pounds submerged 20 feet. It is a general characteristic of small and deeply submerged charges of the explosive compounds, and of some quick acting explosive mixtures as well, that at the instant of detonation, before any disturbance of the water at the surface is visible, three sharp sounds are heard resembling raps upon a hard substance. They are of nearly equal intensity; but the interval of time between the first and the second appears to be longer than between the second and the third. That these repetitions are not simply echoes, and that there are really more than three of the impulses, although the ear hardly detects a greater number, have been conclusively proved in several instances where a gauge clutch happened to be out of order. In such cases several successive indentations in the bottom of the lead have been made by the centre pin as the cylinder moved laterally under the upward jerk given by the buoy. Successive impulses may also be distinctly felt by one standing in a boat near the explosion; and if the hand be placed in the water, sensations resembling electric shocks are experienced. The influence of the shock upon fish is noteworthy. In the immediate vicinity, even of small charges, death appears to be instantaneous. At a greater distance the air bladder is ruptured, and the air ballast escaping into the abdomen, the fish floats upon its back at the surface, although able to swim with considerable speed. At still longer ranges the effect appears to be momentary, simply causing an upward dart into the air. Even five pounds of dynamite will produce this effect upon a shoal of menhaden at distances of several hundred yards, showing that the nervous system of that fish is one of the most sensitive of known gauges.

The jet, as well as the sound, is greatly influenced by the submergence. As small charges afford the best opportunity for studying this phenomenon in detail, the following summary of many records upon explosive compounds is given. A charge of one-fourth of a pound submerged about 35 feet occasions no marked disturbance at the surface, but bubbles of gas continue to rise for many seconds. Fish at 100 yards distance often leap into the air. A half pound charge detonated 6 feet below the surface produces a sharp report, and throws up a jet from 20 to 30 feet into the air. With a one pound charge submerged 35 feet, the buoy supporting the ring instantly rises about 2 feet and sinks back out of sight. An upward boiling motion of the water begins about 12 seconds after the explosion. In a strong current this may appear several feet away from the buoy. When the charge is submerged 25 feet the boil rises quicker, and the buoy often reappears with it. With a two pound charge submerged 35 feet the phenomena are similar, the boil appearing in about 9 seconds. With a 3 lb. charge at the same depth the upward current of water assumes the appearance of a small dome at the surface, appearing about 5 seconds after the explosion. The buoy rises from 4 or 5 feet instantly, and sinks back out of sight. As the charge is increased to 5, 8, and 10 pounds, the depth remaining the same, the greater intensity of action is shown by a quicker motion of the buoy, which is also surrounded by a mist thrown upward from the surface. The dome appears in a second or two, and expands, into a small white jet of water 8 or 10 feet high. A boat 50 feet distant from the buoy receives a jar sufficient to lift small articles. Fishes of the herring family dart into the air as far off as the eye can conveniently distinguish them, those within a radius of a couple of hundred feet being crippled by the concussion. With explosive mixtures the effects are similar but less intense. For example, 25 pounds of mortar powder, fired 35 feet below the surface, cause a misty shower to rise a foot or two above the water; the buoy shoots up to its full length and falls upon its side; then a white dome rises around it about 10 feet high. When a

strong iron case is used, three sharp raps are heard, which are not often noticed with a wooden case. When 50 pounds of mortar powder are fired five feet below the surface, the jet is about 170 feet high; at 16 feet it is about 40 feet high; at 35 feet it is 20 to 30 feet high; and at 63 feet there is simply a large upward boil around the buoy, occurring several seconds after the explosion. In deep explosions the buoy always shoots upward, and often subsides before any disturbance is seen at the surface.

The *Bulletins de l'Academie Royal de Belgique* contain an extract of a work upon *experimental ballistics*, by M. Melsens, in which the learned writer propounds a remarkable theory in regard to the action of the air existing in front of projectiles, and which forms one with the solid projectile during the greater part of its course.

M. Melsens describes one of the various contrivances he made use of for receiving the air in front of a projectile moving at a great speed. It consists practically in firing a bullet in a tronconical aperture made in a solid block of steel or cast-iron. At the extreme end of the cone, towards the summit, the aperture of the cone may be several millimetres in diameter; it is made to communicate with iron tubes previously filled with water, which extend into a pneumatic trough containing a bell for the reception of the air.

When a spherical leaden ball enters the cone, which is constructed so as to prevent the outflow of the water, the air in front of it is driven forward; a portion of the ball enters the orifice of the cone, and the remainder, being wedged in it, forms an obstruction and prevents the escape of the water. The part in the cone often terminates in a perfect point, very sharp and tapering; sometimes a characteristic stricture is observed, which recalls what has been named in liquids *the contraction of the vein*. Bullets are seen in which this bulging out forward is ready to separate. Detached and isolated drops are found in the tube, as if the solid lead had flowed like a liquid.

M. Melsens' experiments differ from those of M. Tresca, in the fact that while in the former we find drops that are entirely free, and every stage of whose formations we can to a certain extent follow, in the latter the flowing of the solid lead, under high pressure, causes the converging motions of the molecules pressing on all sides towards the orifice to yield to the pressures which, spreading from the upper part of the block, extend throughout the whole mass, determining what in liquids has been termed the contraction of the vein.

Upon the subject of the resistance of air in gun-barrels Prof. Colladon has addressed to M. Melsens a letter containing some curious and little known facts, which we think useful to reproduce *in extenso*.

"MY HONOURED COLLEAGUE,—Your work on experimental ballistics, and the interesting phenomena which you have discovered and described in the paper you sent me, determined me to communicate to you an old experiment which I have often repeated, either before my scholars at the Ecole Centrale des Arts et Manufactures, in Paris, or later, during my course of instruction in the scientific branch at the Academy of Geneva.

"The Swiss carbines used in target practice about sixty years ago were pretty heavy pieces; the barrels, generally very thick, were longer than those of modern rifles; besides, at that time, they used spherical balls. There are examples of target-shooters who, on a wager, loaded their carbine with a round ball, grasped firmly the extremity of the barrel, closed the muzzle with their thumb, and fired their piece without the thumb being injured, which presupposes a rare strength in the wrist and muscles.

"Having been entrusted with the instruction in theoretical and applied mechanics, at the Ecole Centrale des Arts et Manufactures de Paris, in 1830, shortly after the formation of that Institution, I introduced in the course of my lectures a great many new experiments, and set in motion before my scholars apparatus or pieces of machinery borrowed from private parties. Among other ex-

periments, I used to repeat every year, as I did later at the Academy of Geneva, an experiment recalling that which I communicated to you.

"I loaded heavily, by means of compressed air, the hollow iron breach of an air-gun, then screwing down the barrel, I introduced in it a round leaden ball, moving freely, but with a diameter very little less than that of the bore of the gun. Placing then the air-gun in an upright position, with the stock resting on the floor, I grasped firmly the extremity of the barrel, and pressing tightly my thumb over the muzzle, I ordered my assistant to pull the trigger: my thumb remained undisturbed, and the ball was heard falling back in the barrel. After this, without any additional charge and with the same ball, in the presence of the audience, I fired at a deal board from 1 to 1½ centimetre thick, and the plank was pierced through; generally my assistant, who had implicit trust in my aim, held in his hand the small board, or a piece of glass, in which the bullet made a pretty clear hole with but very few cracks.

The experiment, I repeat, is without any danger to the operator, if he can trust to his muscles, if the barrel is more than 80 centimetres long, if the ball is spherical, and if its diameter differs very little from that of the bore, for this ball must act as a piston, and its whole energy must be exclusively employed in compressing the air whose egress is prevented by the thumb.

"I presume it would be dangerous to load the gun with a bullet of too small a diameter or with small shot. It is hardly necessary to add that the least instability in the vigorous pressure of the thumb, or in the impervious closing of the bore, would cause the bullet to hit, and probably to seriously hurt, the extremity of the thumb. It also seems to me that a conical bullet would prove more dangerous than a spherical one, for, according to the power of the charge and the length of the barrel, the bullet must come very close to the thumb before its energy is spent in the act of compression. At any rate, we would dread the burning of the skin of that part of the thumb closing the orifice, for this is an experiment in every way analogous to that of the pneumatic tinder-box, when compressed with great force; doubtless the time is too short for any serious harm being done. I have repeated the experiment more than a score of times without any injury, either from shock or heat.

"DANIEL COLLADON.

"Geneva, May 31, 1882."

M. Melsens, in publishing this letter, says that on communicating the very curious facts contained in it to several artillery officers, otherwise very learned and quite familiar with subjects on ballistics, they professed entire ignorance of them.—(*Mem. Soc. Ing. Civ.*, p. 190, August, 1882.)

Several rifle barrels having been swollen and burst, a board of officers was appointed, June 12, 1882, to report upon them, and especially as to the cause of their being swollen at the muzzle. On meeting at Springfield, Mass., the board proceed to examine the records of the post, and also considered the results of experiments made by direction of the commanding officer.

They find that in September, 1879 ("Ordnance Notes," No. 117), the following experiments were made by Capt. Greer, Ordnance Department, as indicated by his report as follows:—"Two condemned barrels were taken at random from a lot turned in from the field. Eight or ten rounds were fired from each of them, rags of various sizes having been inserted in the bore, a little below the front sight, without affecting the barrel the slightest. Sand next having been inserted in the muzzle, the barrel was shaken so as to remove all but a few grains which adhered to the fouling; the piece was then fired. This was repeated several times without swelling the muzzle. The barrel was then run into wet sand, and the bore nearly filled for about an inch and a half. After firing in this condition the barrel was found swelled at the muzzle pre-

cisely like those that have been received from time to time from the field. Several pine plugs from 6 to 8 ins. in length were then prepared of a size to fit the bore closely. The second barrel was fired twice with the plugs driven in dry, about one-half their length, twice driven in wet and twice driven in dry, but afterwards swelled by steam, both inside and outside, without injury to the barrel. The enclosed air probably forced the plugs out before the bullets reached them. A plug was then split in two to represent a broken tompon, the air being free to pass by the plug. It was thought the bullet might wedge on the remaining side of the plug, but the barrel was found uninjured after the shot was fired. Occasionally a cup-anvil of the Frankford service shell has been found in the barrel after firing. It was thought possible that one of these might become wedged in the barrel and cause the swelling. To test this question an anvil was driven down squarely across the barrel just opposite the front sight. The piece was then fired without injury to the barrel. A second anvil was driven down to the same position, but obliquely to the axis of the bore. No damage resulted from the firing. A long wad of cotton-waste was then wet and rolled into a spiral, and forced down the barrel several inches by the ramrod. The piece was then fired, when the barrel was found swelled a little beyond the wad, which was probably carried forward a few inches before the bullet wedged upon it." Recently the following experiments were made by direction of Colonel Buffington. A barrel received from the field with a swollen muzzle was cut off back of the swell. The muzzle was then pushed into wet sand and the gun discharged, using the service cartridge, resulting in a swollen muzzle. A second similar gun-barrel was taken, the swollen muzzle cut off, the gun fired, the end thrust into dry sand, and fired again, with no perceptible swelling. It was then fired twice more, with the consequent increase of fouling,—the muzzle end rested in dry sand, just as might easily happen at target practice from carelessness; then it was fired again, and the muzzle found to be swollen. From these experiments it is evident that an obstruction in the bore, particularly sand, will cause a swelling of the barrel. That men frequently lay their guns down or stand with the muzzle resting in the sand no one will probably deny. Such action is liable to pick up sand in the muzzle, particularly after the gun has been fired, resulting in swelling the barrel after firing again. The swelling never takes place from firing a service cartridge when there is no obstruction in the bore.—("Ordnance Notes, U.S.A.," No. 238.)

The new six-inch breech-loading steel rifle has recently been tried by Lieutenant-Commander Folger, U.S.N., at the Naval Experimental Battery: and with a charge of 32 pounds, and a projectile weighing 68 pounds, a muzzle velocity of 2130 feet per second was obtained, while the pressure was but 30,720 pounds per square inch. Considering the conditions of chamber-space (920 cub. ins.), length of bore, and weight of projectile, the results are unsurpassed by any hitherto obtained abroad.—(*Science*, i., 291, April 13, 1883.)

The *Revue Scientifique*, xxviii., 769, December 17, 1882; xxix., 75, January 21, 1883, and 109, January 28, 1883, contains an exceedingly important article by Berthelot, on "Explosives," in which he reviews the work recently done, and states his present belief as to the cause and character of explosive phenomena and the properties of explosive substances. In the discussion of explosions by influence, he takes exception to the theory of *synchronous vibrations* proposed by Abel,* and apparently supported by the experiments of Champion and Pellet, and offers a new theory of his own, which we shall treat of at length later. His method of accounting for the change brought about in the explosive power of gum dynamite, gun-cotton, and the like, by admixture of inert substances, is interesting. He holds that the camphor modifies the co-

hesion of the mass of the substance. The substance thus acquires a certain elasticity and solidity, in consequence of which the initial shock of a detonator propagates itself at the start through a much greater mass of the substance than it would if the camphor were not present. A portion of the energy is expended in rending the mass, while some of it is converted into heat; but this heat is dispersed through a greater mass, hence a sudden and local elevation of temperature capable of inducing chemical and mechanical action cannot be produced but with difficulty, and hence a greater weight of the detonating substance is required where camphor is present. Camphor, however, according to the theory, does not exert any influence on discontinuous powders, and this is shown in practice with potassium chlorate powders. This theory of discontinuity is also illustrated by the statement "that frozen dynamite jelly possesses a sensibility to shock comparable to that of nitro-glycerin if the solidity of the parts has become destroyed by crystallisation."

This work of Berthelot's has been translated by M. Benjamin, and published in *Van Nostrand's Engineering Magazine*, xxix., 100, August, 1883, but it is rarely that we have met with such wretched, slovenly, and unreliable literary work, and it is an added injustice to the eminent author that no reference is made to the source from which the original is drawn. It is only justice to the translator to say that, as he had no opportunity for revising the proof-sheets, he cannot be held responsible for the condition of his article. As this is a work with which all students of explosives must become familiar, and as few of them may meet with it in the original, they will be pleased to hear that the article is to be revised and published in a permanent and convenient form, together with a Bibliography of Explosives, in "Van Nostrand's Science Series."

The same number of *Van Nostrand's Engineering*, p. 125, contains a bright and entertaining article entitled "Who Discovered Gunpowder," being a translation by Lieut. John P. Wisser, from the German of Karl Braun, *Nord und Süd*, June, 1883. The article goes to show that the knowledge of gunpowder was brought to Augsburg in 1353 by a Jew named Tysiles, and that from Augsburg, the preparation of gunpowder, its application to military purposes, and the manufacture of firearms, spread throughout Germany and over the rest of Europe. It is conjectured that this Tysiles came from the Orient, and brought thence a knowledge of Greek fire into the free imperial city of Augsburg. Thus is the story of Berthold Schwarz, the Freiburg monk, relegated to the realm of fiction.

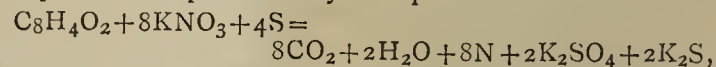
In the *Précis and Translations of the Royal Artil. Inst.*, April, 1883, is a translation by Capt. J. C. Dalton, R.A., from *Memorial d'Artilleria*, April, 1882, on the Portuguese army, from which we learn that the powder factory is at Barcasena, 8½ miles from Lisbon, where the powder is made for the old guns; that for the Krupp guns is procured in Germany. The different classes of powder made at Barcasena have the following compositions:—

Class of Powder.	Mark.	Composition.		
		Salt-petre.	Sulphur.	Char-coal.
Mining powder	MM.	62	18	20
Gunpowder, fine grain.	P.F.	76	10	14
Do., No. 1, extra fine..	P.S.F.N. 1	76	10	14
Do., No. 2	P.S.F.N. 2	76	10	14
Do., large grain	S	75	12.5	12.5
Do., small grain	FF	75	12.5	12.5
Do., rifle	FN	76	10	14
Do., shell	FNC	76	10	14

They have also tried a powder to take the place of the German powder, and in the experiments made with the 9 c.m. gun they obtained with the 33 lbs. charge of the same powder an initial velocity of 1512 f.s. The laboratory is at Braço de Rata, 4½ miles from Lisbon.

H. Güttler proposes to make cartridges of compressed

blasting-powder by cementing the grains together with dextrin. For this purpose he uses a brown-red charcoal made from resin-free wood at a temperature of 270° to 310° C., and which he claims has the formula $C_8H_4O_2$. The mixture of charcoal, sulphur, and nitre is incorporated with the solution of dextrin, corned in grains of 1 to 2 m.m., and after drying pressed into perforated cylinders. These cylinders are dried and shellacked. The reaction on explosion is represented by the equation—



when potash nitre is used. When soda nitre is employed the reaction is similar, but Na takes the place of K.—(*Chemisch-technisches Repertorium*, p. 154, 1883.)

The output of the Spanish Powder Mill at Murcia* for the year 1880-1881 was 102,860 kilos. of powder. Of this 16,084 kilos. were prismatic powder with seven canals.† While this was as good as the English or German powders, it was much cheaper, since it cost but from 48 to 50 cents per kilo.—(*Mitt. Artill. u. Genie-Wesens*, 1883. *Kleine Notiz*, 19.)

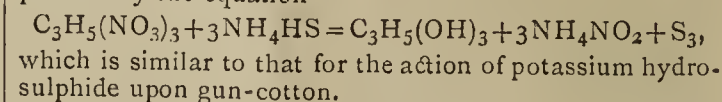
Under the title "Lecture Experiments with Zinc-dust and Sulphur," H. Schwarz calls attention to the vigorous action which attends their union. Ordinarily a mixture of fine iron or fine copper and sulphur is used for showing the phenomena attending chemical union. Schwarz tried zinc-dust and sulphur, and to his surprise his crucible blew up. Experimenting further, he found that a mixture of the substances in atomic proportions is the most useful. This he obtains by passing a mixture of two parts of zinc and one part of sulphur through a sieve. This may be readily ignited by a match, when it burns like gunpowder, with a vivid brilliant flame, somewhat greenish in colour, and leaving only a slight yellowish-white residue of zinc sulphide. It may also be exploded by the blow of a hammer. When tried in a small testing-mortar, 2 grms. of the zinc and sulphur mixture were found to produce the same effect as half a gm. of gunpowder.—(*Ber. Berl. Chem. Ges.*, xv., 15, 2505, Nov. 13, 1882.)

Prof. C. L. Bloxam publishes an article under the title "Re-conversion of Nitro-glycerin into Glycerin," *CHEM. NEWS*, xlvii., 169, April 13, 1883. He states that the following experiments on this subject appear to possess some interest at the present moment:—

1. Nitro-glycerin was shaken with methylated alcohol, which dissolves it readily, and the solution was mixed with an alcoholic solution of KHS (prepared by dissolving KHO in methylated spirit and saturating with H_2S gas). Considerable rise of temperature took place, the liquid became red, a large quantity of sulphur separated, and the nitro-glycerin was entirely decomposed.

2. Nitro-glycerin was shaken with a strong aqueous solution of commercial K_2S . The same changes were observed as in 1, but the rise in temperature was not so great, and the liquid became opaque very suddenly when the decomposition of the nitro-glycerin was completed.

3. The ordinary yellow solution of ammonium sulphide used in the laboratory had the same effect as the K_2S . In this case the mixture was evaporated to dryness on the steam-bath, when bubbles of gas were evolved, due to the decomposition of the ammonium nitrite. The pasty mass of sulphur was treated with alcohol, which extracted the glycerin, subsequently recovered by evaporation. Another portion of the mixture of nitro-glycerin with ammonium sulphide was treated with excess of $PbCO_3$ and a little lead acetate, filtered, and the ammonium nitrite detected in the solution. The qualitative results would be expressed by the equation—



4. Flowers of sulphur and slaked lime were boiled with

* *Proc. Nav. Inst.*, viii., 673.

† *Ibid.*, viii., 463.

water till a bright orange solution was obtained. This was filtered, and some nitro-glycerin poured into it. The reduction took place much more slowly than in the other cases, and more agitation was required, because the nitro-glycerin became coated with sulphur. In a few minutes, the reduction appearing to be complete, the separated sulphur was filtered off; the filtrate was clear, and the sulphur bore hammering without the slightest indication of nitro-glycerin.

This would be the cheapest method of decomposing nitro-glycerin. Perhaps the calcium sulphide of tank-waste, obtainable from the alkali works, might answer the purpose.

The reducing action of alkaline sulphides on nitro-glycerin has been pointed out some time since,* and its quantitative application is previously mentioned in these notes.†

On page 448, vol. viii., an account is given of the experiments of Mr. Volney and Dr. Henry Morton on the separation of nitro-glycerin from nitro-saccharose. Mr. R. S. Penniman, of the Atlantic Dynamite Works, writes, that "as I first suggested and performed the experiment described in 'Notes' No. 2, for the separation of nitro-glycerin from nitro-sugar by the distillation of the nitro-glycerin, I may be permitted to state that this method is not absolutely accurate in its determination of amount of nitro-sugar present, for the reason that the nitro-sugar is also slowly volatile at this temperature, 250° F., and some is driven off with the nitro-glycerin."

S. H. Hinde proposes a new explosive mixture composed of 64 parts of nitro-glycerin, 12 of ammonium citrate, 0.25 of ethyl palmitate, 0.25 of calcium carbonate, 23 of coal, and 0.50 of sodium carbonate. (*Chemisch-technisches Repertorium*, p. 153, 1883.)

"Pyronome" is the name given to a new explosive mixture by M. Sandoy, consisting of 69 parts of saltpetre, 9 of sulphur, 10 of charcoal, 8 of metallic antimony, 5 of potassium chlorate, 4 of rye flour, and a few centigrms. of potassium chromate. These are to be mixed in an equal volume of boiling water and the mass evaporated down to a paste, dried, and powdered as wanted. This mixture is said to be cheaper than dynamite, but its manufacture and use must be attended with considerable danger. (*Chem.-tech. Repertorium*, p. 154, 1883. *Boston Journal of Chemistry*, xvi., 26, Feb., 1882.)

B. G. and F. L. Benedict have proposed the following mixture for use in primers to replace fulminating mercury:—Amorphous phosphorus, 2 parts; minium, 8 parts; potassium chlorate, 2 parts. The oxides of mercury or manganese may be used in the place of the minium. (*Chemisch-technisches Repertorium*, p. 153, 1883.) This differs but little from the caps which caused the explosion in the Rue Beranger, Paris, May 14, 1878. Of these the kind called "single" consisted of—

Potassium chlorate	..	..	12 parts.
Amorphous phosphorus	..	6	"
Lead oxide	..	..	12 "
Resin	..	..	1 "

while the "double" were composed of—

Potassium chlorate	..	..	9 parts.
Amorphous phosphorus	..	1	"
Antimony sulphide	..	1	"
Sulphur, sublimed	..	..	0.25,"
Nitre	..	..	0.25,"

—(*Revue Scientifique*, xxix., 80, Jan 21, 80, 1882.

A new explosive‡ has just been patented in England by Dr. C. W. Siemens. The compound is a mixture of saltpetre, chlorate of potash, and a solid hydrocarbon, and is and is suitable both for mining purposes and firearms, while, if ignited in the open air, the combustion takes

place slowly and imperfectly, and therefore without danger. The incorporation of the ingredients is by preference effected as follows:—The saltpetre, chlorate of potash, and hydrocarbon (for which may be taken, paraffin, asphaltum, pitch, caoutchouc, gutta-percha, &c.) are mixed together in pulverulent form by passing through sieves or otherwise, and the mixture is then treated with a liquid volatile hydrocarbon, which acts as a solvent to the solid hydrocarbon. A plastic mass is thus produced, which is then formed into cakes or sheets by passing through rollers or otherwise, and is rendered hard by evaporating the liquid solvent used, the sheets or cakes so produced being then converted into grains or pieces of any desired size, in the same manner as ordinary gunpowder. The new compound, which has about the same density as ordinary gunpowder, and is very hard, possesses with equal volume more than double the explosive force of the latter. The intensity of explosion can be regulated at will by varying the proportions of the ingredients and the size of the granules. These proportions should, generally speaking, be such that for each volume of the hydrocarbon, when converted into a gaseous state, there shall be present in the other ingredients three volumes of oxygen.—(*Wash. Sunday Herald*, Jan 14, 1883.)

(To be continued.)

THE BIOLOGICAL EXAMINATION OF WATER.

By C. J. H. WARDEN, Surg. H.M.'s Bengal Army,
Professor of Chemistry, Calcutta Medical College.

(Concluded from p. 89.)

V. Inferences to be drawn from Results.

It has already been pointed out that micro-organisms are normal constituents of water, and in drawing conclusions from the results of analyses, both the number and

TABLE I.

Source of the water.	Number of germs in one cubic centimetre.
Water from the pressure tube (<i>druckrohr</i>) in Falkenberg—	
In August	50,000,000
In October	46,000,000
The ditch in which drain waters of the filtering fields near Falkenberg are collected	44,000
Between Falkenberg Marzahn	76,000
The water from separate drain pipes at Falkenberg	460
.. .. .	860
.. .. .	4400
.. .. .	48,000
.. .. .	420,000
The water of the Wuhle	830,000
The Spree above the entrance of the Wuhle	210,000
The limiting ditch	616,000
The Spree in the town—	
Above Panke	940,000
Below Panke	1,800,000
The Spree at Belleme—	
First examination	1,640,000
Second examination	4,480,000
The Spree at Charlottenburg	10,180,000
The Spree at Spandau—	
First examination	220,000
Second examination	5,000,000
The hydrant water in the Gesundheits Amt Berlin from Tegeler lake water in many examinations	160 to 250
Tegeler lake	3740
Well water from different wells amounted to	40 to 160
But reached in some cases	4000 and 12000

* Mowbray, 3d Ed., 1874, p. 58. W. N. Hill, Rept. Secy. Navy, 1876, p. 168.

† *Nav. Inst. Proc.*, ix., 294

‡ *Nav. Inst. Proc.*, ix., 298.

TABLE II.

Source of the water.	Colour.	Odour.	Transparency.	Per 100,000 parts.			
				Hardness.		Total solids at 100° C.	Cl.
				Total.	Perman't.		
1. Liquid sewerage from the pressure tube—before filtration.	—	Putrid odour on long standing, which increases.	Dark flocky masses.	—	—	256.46	—
After filtration through paper.	—	Distinct putrid odour.	Turbid by white flocks, which settle on standing.	13.25	7.28	107.06	23.43
2. Water from the N. part of the sewers.	—	Faint unpleasant smell, which disappears on longer standing.	On examination turbid. The turbidity subsides on longer standing and forms a precipitate contng. oxide of iron.	14.16	3.60	83.88	18.46
3. Ditch 20 paces above its entering in the Wuhle.	—	As No. 2.	As No. 2.	14.35	3.90	88.26	18.46
4. Wuhle at the crossing of the road.	—	On first examination, and after keeping, hardly any odour.	On examination slightly turbid; after 3—4 days flocks subside; contain oxide of iron.	15.20	4.0	73.42	14.91
5. Limiting ditch at exit from the filtering fields.	—	On examination slight odour, which is lost after some time.	On examination rather strongly turbid; turbidity subsides after 3—4 days; flocks contain oxide of iron.	15.20	4.0	71.58	14.20
6. Limiting ditch at entrance into the lake of Rummelsburg.	—	No odour, even after standing.	On examination faintly turbid; after 3—4 days separation of a slight precipitate, which contains oxide of iron.	11.78	3.51	44.18	6.39
7. Rummelsburglake 40 paces below the entrance of the limiting ditch.	Nearly colourless, very faintly yellowish.	No odour, even after standing.	On examination nearly transparent; after 3—4 days very slight precipitate, which contained oxide of iron.	5.33	—	16.60	2.13
8. Rummelsburglake near the ice-works.	As No. 7.	As No. 7.	As No. 7.	5.33	—	19.18	2.13
9. Spree above Köpenick.	As No. 8.	As No. 8.	As No. 8.	5.36	—	19.14	2.13
10. Spree 200 paces above entrance of the Wuhle.	As No. 9.	As No. 9.	Transparent. On standing separation of very few white flocks.	5.36	—	14.34	2.13
11. Wuhle 200 paces above its entrance into the Spree.	As No. 10.	As No. 10.	Nearly transparent. After long standing separation of a few brown flocks which contain oxide of iron.	9.0	2.60	53.10	9.33
12. Spree 200 paces below the entrance of the Wuhle.	As No. 11.	As No. 11.	Nearly transparent. After long standing separation of very few yellow flocks.	5.36	—	14.58	2.13
13. Waterworks of Stralau before filtration.	As No. 12.	As No. 12.	As No. 12.	5.36	—	17.0	2.13
14. Ditto, after filtration.	As No. 13.	As No. 13.	Transparent, even after long standing.	5.36	—	16.40	1.99

TABLE II. (*continued.*)

Per 100,000 parts. NaCl.	Parts.				Reducing power of organic matter present in 100,000 parts of the water on KMnO ₄ .	Microscopic examination of the fresh water in a cupped slide, and also of dry stained cover-glass preparations.	Number of germs present in <i>one</i> cubic centimetre of the water.
	SO ₃ .	N ₂ O ₅ .	N ₂ O ₃ .	NH ₃ .			
—	—	—	—	—	—	Numerous movable and stationary micro-organisms, consisting of monads, colourless algæ, bacilli, micrococci in chains, and zooglæa masses. Vibrios, spirilla. Abundant amorphous debris. Around the edge of the dried drop on the cover-glass there was no appearance of crystallisation.	38,000,000 colonies, of which 989,000 liquefied the gelatin.
38.625	7.92	0.25	Nil.	8.440	22.12		
30.45	5.48	2.12	0.1500	1.60	4.46	Few colourless algæ, separate movable bacilli, few stationary bacilli, few micrococci. Crystalline bodies abundant.	87,000 colonies, of which 3800 liquefied the gelatin.
30.45	4.48	1.30	0.1875	1.8	4.28	Colourless algæ, a tolerable number of movable short and thin bacilli, a few larger, partly movable. Pretty large number of micrococci in masses, with detritus. Crystalline bodies in abundance.	409,000 colonies, of which 6500 liquefied the gelatin.
24.57	4.10	0.47	Nil.	1.44	5.69	Single colourless algæ and vibrios, many short fine movable and stationary bacilli. Heaps of micrococci. Crystalline bodies.	55,000 colonies, of which 1650 liquefied the gelatin.
23.40	3.20	0.33	0.0665	1.420	3.99	Single spirilla and colourless algæ; pretty large number of bacilli and micrococci, the first partly movable. Crystalline bodies.	210,000 colonies, of which 3680 liquefied the gelatin.
10.53	3.20	0.08	Nil.	0.560	2.68	Pretty large number of colourless algæ. Short fine and stationary bacilli. Single groups of large, thick, stationary bacilli. No crystalline bodies.	80,000 colonies, of which 540 liquefied the gelatin.
3.51	Trace.	Nil.	Nil.	0.028	2.72	Small movable bacilli; very few large micrococci joined in couples. No crystalline bodies.	32,000 colonies, of which 850 liquefied the gelatin.
3.51	Trace.	Nil.	Nil.	0.01	3.44	Same as No. 7.	43,000 colonies, of which 260 liquefied the gelatin.
3.51	Trace.	Nil.	Nil.	0.011	2.77	Pretty many short stationary bacilli. No micrococci. No crystalline bodies.	82,000 colonies, of which 140 liquefied the gelatin.
3.51	Trace.	Nil.	Nil.	0.008	2.59	Same as No. 9.	115,000 colonies, of which 120 liquefied the gelatin.
15.37	3.0	Nil.	Nil.	1.04	2.59	Pretty many movable and stationary bacilli of middle size; fragments of colourless algæ. Single heaps of micrococci. A slight separation of crystalline bodies.	52,000 colonies, of which 920 liquefied the gelatin.
3.51	Trace.	Nil.	Nil.	0.018	2.62	Same as No. 9.	118,000 colonies, of which 95 liquefied the gelatin.
3.51	Trace.	Nil.	Nil.	0.011	2.68	Same as No. 9.	125,000 colonies, of which 135 liquefied the gelatin.
3.276	0.96	Nil.	Nil.	0.004	2.50	No micro-organisms detected.	120 colonies, of which 5 liquefied the gelatin.

the character of the bacilli must be taken into consideration. As regards number, there is evidence to show that the purer the water the smaller the number of bacilli present. The variations in number are shown in Table No. I.* As regards general characters of the bacilli, at present it is assumed that those which liquefy the gelatin are more harmful than those which do not. But it appears to me that the evidence on this point is not conclusive. An alteration in the chemical composition of the culture-gelatin is apparently sufficient to cause colonies which did not liquefy ordinary meat peptone gelatin, to liquefy the modified culture medium. In Table No. II.† the results of the chemical and biological examination of fourteen samples of water from various sources are tabulated.

The results of analyses 13 and 14 in Table No. II. are interesting, and demonstrate in a striking manner the effects of efficient filtration in removing micro-organisms.

The employment of the biological method for the examination of water supplied by public companies, ought on these grounds, to prove useful. As a means, also, of ascertaining the relative value of domestic filters, the bacteriological examination of the water before and after filtration appears to be the only method likely to afford reliable indications.

In conclusion I would gratefully acknowledge the very great obligations I am under to Prof. Koch and to Dr. Gaffky for the valuable instruction I received at their hands during the period of my study at the Gesundheits Amt Berlin.

NOTE ON THE ESTIMATION OF IODIDES IN PRESENCE OF BROMIDES AND CHLORIDES.

By F. L. TEED, D.Sc.

THE fact that a soluble iodide will precipitate silver from a solution of silver chloride in an alkaline chloride is well known, but, as far as I am aware, has not as yet been utilised for the quantitative estimation of iodides.

I took a measured quantity of standard silver nitrate solution, and added potassium chloride till the precipitate first formed was re-dissolved. I then ran into this from a burette the solution of the iodide (saturated, or nearly so, with potassium chloride so as to avoid the precipitation of silver chloride by dilution) till no further precipitate was produced. The silver iodide clots well, especially on warming and shaking. Results good. By using potassium bromide instead of chloride, both for the silver nitrate and the solution of the iodide, the end of the reaction was obscured, giving bad results. But a moderate amount of bromide in presence of the iodide does not appear to interfere.

8, Victoria Chambers, Westminster, S.W.
August 21, 1885.

THE RECOGNITION OF ARSENIC IN CHEMICO-LEGAL INVESTIGATIONS.

By H. BECKURTS.

AFTER giving a conspectus of the previous researches of Rose, Hager, Fischer, and others in the same direction, the author recommends the following process:—The substances in question are comminuted as far as necessary, stirred up to a thin paste with hydrochloric acid at 20 to 25 per cent (obtained by distilling the strongest procurable hydrochloric acid with ferrous chloride, and rejecting the first 30 per cent which passes over), and with about

20 grms. of a solution of ferrous chloride at 4 per cent. (This ferrous chloride is obtained by dissolving iron-filings in hydrochloric acid at 20 to 25 per cent, and evaporating the filtered solution to dryness.) This mixture is placed in a roomy tubulated retort, the neck of which is placed sloping upwards, and is connected at an obtuse angle with a Liebig's condenser. One-third is distilled over, causing about 3 c.c. to pass over per minute. Organic masses containing large proportions of water must either be partially dried before the addition of the acid (in case of need after approximate neutralisation with sodium carbonate, to prevent loss of arsenic), or be mixed with hydrochloric acid stronger than 25 per cent. If the quantity of arsenic present is not too large it passes entirely over in the first distillate; otherwise, when the retort has had time to cool, 100 c.c. of hydrochloric acid are added, and the distillation is renewed. The more concentrated the acid the more easily the arsenic passes over as arsenic chloride. The distillate may be placed at once in the Marsh apparatus, or it may be treated with hydrogen sulphide, or the bulk of the hydrochloric acid may be removed, the arsenic oxidised and precipitated as magnesium-ammonium arseniate; or the distillate may be neutralised with potassium carbonate, and the arsenious acid determined volumetrically with centinormal solution of iodine. By this process the arsenic present as arsenic or arsenious acid passes entirely into the distillate as arsenic chloride. Arsenic sulphide is chiefly decomposed on the first distillation. The oxidised portion of the free acid passes over entirely as chloride, as also a small part of that not oxidised.—*Zeitschrift für Analytische Chemie*, vol. xxiv., p. 482.

NEW REACTION FOR TITANIC ACID.

By R. FRESENIUS.

SCHÖNN was the first to make known the valuable reaction for titanic acid depending on the intense yellowish red colour which its acid solutions assume if mixed with a solution of hydrogen peroxide. In case of very great dilution the colour is pure yellow. Heppe seems to have discovered this reaction independently, for he mentions it under his own name, and with the additional remark, that ether, if shaken up with the yellowish red liquid, does not take up the colour. Upon what chemical process this reaction depends it has not been certainly ascertained. Schönn, who ascribed it first to a yellow modification of titanic acid, considered afterwards that it was due to a process of oxidation. Against the assumption that it might depend upon a process of reduction we must take the circumstance that no oxygen is evolved during the reaction.

The author calls attention to a reaction, apparently very similar, which without doubt depends upon a process of reduction. It is characteristic of titanic acid, and is very sensitive, if not quite so much so as that with hydrogen peroxide, which, according to Weller, becomes indistinct only when 1 c.c. of the solution contains 1.50 m.grm. titanic acid, or less.

The reaction is obtained by the yellowish liquid, which is produced by the brief action of aqueous sulphurous acid upon zinc-turnings or granulated zinc, consequently by Schützenberger's hydro-sulphurous acid, or Bernthsen's hypo-sulphurous acid, but not by sulphurous acid or dithionous acid.

If this reagent is mixed with a rather concentrated sulphuric or hydrochloric solution of titanic acid,—e.g., one containing in 1 c.c. 1.5 m.grm. titanic acid—we obtain at once an intense red colour, inclining to orange, which soon becomes orange, then yellow, and gradually fades away. The more free acid is present the more rapid is the change of colour. On a further addition of the reagent the reaction is renewed.

If the red liquid is shaken up with ether the latter liquid

* From the "Bericht der Deputation für die Verwaltung der Kanalisationswerke für der Zeit vom 1st April, 1882, bis zum 31st May, 1883.
† *Ibid.*

does *not* become coloured. The author calls particular attention to this circumstance, because in the fifteenth edition of his "Qualitative Analysis," which has just appeared, and in which this reaction is mentioned, the word "not" has been by mistake omitted.

If a solution of titanous acid contains only 0.15 m.grm. or less of titanous acid in 1 c.c., we obtain on adding the reagent only a yellow colour. If a test-tube is filled with the liquid and examined from above, it can be easily recognised when 1 c.c. contains only 0.02 m.grm. titanous acid, or even less. The sensitiveness of the reaction is consequently about the same as that which Weller gives as the limit of the hydrogen peroxide reaction. According to the author's experiments, however, the former is somewhat less sensitive.

As to the applicability of the hydro-sulphurous reaction, it can be used only if no other acids or oxides are present whose solutions are reduced with a colouration of the liquids. Hence it is not available in presence of molybdic, tungstic, chromic, niobic, and vanadic acids, since on adding hydro-sulphurous acid to the acid solutions of the above acids, molybdic acid gives a colouration which is bluish green, green, or brown; tungstic acid a deep blue; chromic acid, a green; vanadic acid, light blue, becoming brown; and niobic acid, a light blue.

As the above-described titanous reaction is produced only by hydro-sulphurous, but not by sulphurous or dithionous acid, a solution of titanous acid may serve as a reagent for hydro-sulphurous acid, and especially for its distinction from sulphurous and dithionous acid.—*Zeitschrift für Analytische Chemie*, vol. xxiv., p. 410.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from p. 88).

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
|| Following a date signifies publication discontinued.

116. KRITISCHE ZEITSCHRIFT FÜR CHEMIE, PHYSIK UND MATHEMATIK. Herausgegeben in Heidelberg von A. Kekulé, F. Eisenlohr, G. Lewinstein, M. Cantor. 1 vol., 8vo. Erlangen, 1858.

Continued under the title:

- [a] Kritische Zeitschrift für Chemie, Physik, Mathematik und die verwandten Wissenschaften und Disciplinen, als Pharmacie, Technologie, Agriculturchemie, Physik und Mineralogie. Unter Mitwirkung von Fachmännern, herausgegeben von E. Erlenmeyer und G. Lewinstein. 1 vol. (II.), 8vo. Erlangen, 1859.

Continued under the title:

- [b] Zeitschrift für Chemie und Pharmacie. Correspondenzblatt, Archiv und kritisches Journal für Chemie, Pharmacie, und die verwandten Disciplinen. Unter Mitwirkung von Fachmännern, herausgegeben zu Heidelberg von E. Erlenmeyer und G. Lewinstein. 4 vols. (III.-VII.), 8vo. Erlangen [later, Heidelberg], 1860-'64.

Continued under the title:

- [c] Zeitschrift für Chemie. Archiv für das Gesamtgebiet der Wissenschaft. Unter Mitwirkung von F. Beilstein und Rud. Fittig, herausgegeben von H. Hübner, Neue

Folge. 7 vols. (VIII.-XIV.), 8vo. Göttingen, 1865-'71.||

KRÖNIG, A.

See Journal für Physik und physikalische Chemie.

117. LABORATORIUM (Das). Eine Sammlung von Abbildungen und Beschreibungen der besten und neuesten Apparate, zum Behuf der praktischen und physikalischen Chemie. 44 nos., 4to. Weimar, 1825-'40.

118. LABORATORY (The). A monthly journal of the progress of chemistry, pharmacy, medicine, recreative science, and the useful arts. By J. F. Babcock. 2 vols., 4to. Boston, 1874-'76.

119. LABORATORY (The). A weekly record of scientific research. 1 vol., 8vo. London, April to October, 1867.||

LABORATORY (The).

See American Laboratory.

LARTIGUÉ, A.

See Répertoire de pharmacie.

LAURENT (A.) ET GERHARDT (Ch.).

See Comptes-rendus mensuels des travaux chimiques.

LIEBIG'S ANNALEN.

See Annalen der Pharmacie [c].

LIEBIG AND KOPP'S JAHRESBERICHT.

See Jahresbericht über die Fortschritte der reinen, pharmaceutischen und technischen Chemie.

120. LISTY CHEMIKE. —vols. v Praze, 18**-'81+

LONDON CHEMICAL SOCIETY.

See Proceedings of - - -

LÖWIG, C.

See Repertorium für organische Chemie.

MAANDBLAD VOOR TOEGEPASTE SCHEIKUNDE.

See Toegepaste Scheikunde.

MACKENSIE, COLIN.

See Mémorial pratique de chimie manufacturière.

121. MAGAZIN FÜR APOTHEKER, CHEMISTEN UND MATERIALISTEN. Herausgegeben von Joh. Casp. Elwert. 3 parts, 8vo. Nürnberg, 1785-'87.

Continued under the title:

- [a] Repertorium für Chemie, Pharmacie und Arzneimittellkunde. Herausgegeben von Joh. Casp. Elwert. 8vo. Hildesheim, 1790 [second edition in 1796].

122. MAGAZIN FÜR DIE HÖHERE NATURWISSENSCHAFT. UND CHEMIE. 2 vols., 8vo. Tübingen, 1784-'87.

MAGAZIN FÜR DIE NEUESTEN ERFAHRUNGEN - - - DER PHARMACIE. *See Nordische Blätter für Chemie [b].*

MAJOCCHI, G. A.

See Annali di fisica, chimica e matematiche; also, Giornale di fisica, chimica ed arti.

MALY, RICH.

See Jahresbericht über die Fortschritte der Thierchemie.

MARTIN, CH.

See Répertoire de chimie, de physique [etc.].

MAUGHAM, W.

See Annals of Chemical Philosophy.

123. MECHANIC AND CHEMIST. 8 vols. London, 1836-42.

124. MÉLANGES PHYSIQUES ET CHIMIQUES tirés du Bulletin physico-mathématique de l'Académie Impériale des sciences de St. Pétersbourg. 1846-'82. 12 vols., 8vo. St. Pétersbourg, 1854-'84+

125. MÉMORIAL PRATIQUE DE CHIMIE MANUFACTURIÈRE. Par Colin Mackensie. 3 vols., 8vo. Paris, 1824.

126. MEMOIRS OF THE COLUMBIAN CHEMICAL SOCIETY OF PHILADELPHIA. 2 vols., 8vo. Philadelphia, 1813, '14.

(To be continued).

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 5, Aug. 3, 1885.

Oxalic Acid in Vegetation: Methods of Analysis.—MM. Berthelot and André.—The authors, after objecting to the methods hitherto used for the detection and determination of oxalic acid in plants, give a process which we purpose reproducing in detail.

Vapour Density of Thorium Chloride, and the Formula of Thorium Oxide.—L. Troost.—The author has obtained the values 5.90, 7.01, and 7.49, figures much nearer the number 6.48, corresponding to the formula of a monochloride, than to the number 12.96, which the formula of a dichloride would require. Hence he assumes for the chloride the formula ThCl ($\text{Th} = 58.1$), and for the oxide ThO . He remarks that this is not the only occasion when the determination of vapour densities has led to results different from those calculated accordingly to the specific heat.

Formation of Crystalline Zinc Hydrate.—J. Ville.—Crystalline zinc hydrate is obtained by the action of potassa upon the neutral or basic zinc carbonates.

Benzine Hexabromide.—On comparing the action of bromine upon benzine with that of chlorine, it is seen that it furnishes chiefly a monobrom-compound, with a smaller proportion of a hexa-bromide. With chlorine the hexa-chloride predominates, accompanied by benzine tri- and tetra-compounds; of the mono-compound very little is produced. In proportion as the proportion of addition-products diminishes, the degree of substitution becomes less and less advanced.

Formation-Heat of the Picrates.—M. Tscheltzow.—The solution-heats of hydrated salts of the same composition are almost constant. The solution-heats of the anhydrous salts have the same sign as the anhydrous chlorides and nitrates of the same metals. The salts of barium and lead absorb heat; those of calcium, strontium, magnesium, zinc, and copper liberate heat. The neutralisation-heats have almost the same values as for nitric and hydrochloric acids. They are conformable to the law of Andrews, and foreseen by that law, as well as the modules of substitution. The formation-heats of the solid anhydrous picrates show that the relative order of affinity of bases for solid picric acid follows a very different course for picric acid and for formic and acetic acids. The difference between the formation-heats of the potassium and zinc salts is 18.6 for the acetates but 31.7 for the picrates.

Essential Oil of Lemon.—MM. Bouchardat and Lefont.—This oil is very complex and is formed chiefly of carbides, $\text{C}_{20}\text{H}_{16}$, and a little cymene. The most plentiful of the carbides is citrene, which boils about 178° , having a rotatory power upwards of $+105^\circ$, and giving directly an inactive solid dihydrochlorate. There are present, also, in small proportions several terebenthenes which begin to boil below 162° , and which yield monohydrochlorates differing among themselves in their rotatory power.

Moniteur Scientifique, Quesneville.
Vol. xv., July, 1885.

Report on certain Experiments performed during the months of August, September, and October, 1883, or Refutation of the Experiments and Opinions of Dr. Freire on the Yellow Fever.—J. B. Harrison, Professor of Chemistry, and Rev. J. H. Sutton Monckey,

Chaplain to the Garrison of Barbadoes.—The authors, after a long series of experiments, find themselves unable to confirm the views of Dr. Domingo Freire, of Rio Janeiro, on the microbes of yellow fever, and especially on the graves of the patients being permanent sources of infection.

Preparation of Aqueous Solutions of Carbon Disulphide and of other Antiseptic Preparations by means of the Sulpholeates.—A. Müller Jacobs.—With 1 part of an alkaline sulpholeate and 1 or 2 parts of benzol, carbon disulphide, oil of turpentine, &c., we obtain perfectly clear liquids of an oily constitution which, on the addition of a few drops of ammonia, dissolve in water in any proportion. With the aid of heat sulphur, camphor, thymol, naphthol, phenol, &c., may be dissolved in the sulpholeates in considerable proportions.

Critical Remarks on the Fixation of Aniline Colours upon Cotton by means of Tannin.—Dr. O. N. Witt.—The author explains the action of tartar emetic in fixing upon the fibre the combination of tannin and and colouring-matter. He contends that the antimony-potassium oxalate may be advantageously used instead of the corresponding tartrate.

Patents in the Chemical Arts taken in France: Selection of Patents connected with the Chemical Arts taken in France.—French patent lists for the month of April.

An Alleged Synthesis of Saccharose.—P. Cazeneuve and G. Linossier.—From the *Journal de Pharmacie et de Chimie*.

News from Below the Sphere.—V. Meunier.—A description of the Echidna, with special reference to its reproduction.

Determination of Tartaric Acid in Argols.—G. Kraemer.—From the *Journal of the Dyers' Society*.

Soldering and Repairing Platinum Vessels in the Laboratory.—J. W. Pratt, F.C.S.—From the CHEMICAL NEWS.

Alleged Decomposition of Quinine in Contact with Lime.—From the *Pharmaceutical Journal*.

Patents taken Abroad.—Abridged specifications of five English patents.

Platinum Carbides Formed at Low Temperatures.—Dr. A. B. Griffiths.—From the CHEMICAL NEWS.

Separation of Metals Precipitated by Hydrogen Sulphide.—J. Barnes.—From the CHEMICAL NEWS.

Hubl's Method of Assaying Oils and Fats.—Russell W. Moore.—From the *American Chemical Journal*.

Zeitschrift für Analytische Chemie.
Vol. xxiv., Part 3, 1885.

Criticisms and Experiments on the Knop-Hüfner Method for the Determination of Urea.—Carl Jacoby.—In this extensive memoir the author concludes that the Liebig-Pflüger method is excellent for solutions of pure urea, but not for urine. It cannot be used for an exact determination of the total nitrogen in urine, as it yields regularly lower values than the procedures of Voit-Seegen or Will-Varrentrapp. The Knop-Hüfner method when properly conducted is suitable for exact scientific determinations.

Detection and Determination of Fluorine.—G. Tammann.—This paper will be given at length.

Vesuvian Humite, Chondrodite from Myakopparberg and Humit from Ladugrufvan.—Dr. F. Carl von Wingard.—An examination of the humite minerals, with especial reference to their fluorine.

Qualitative Detection of Fatty Oils in Mineral Oils.—F. Lux.—This memoir will be inserted in full.

Composition and Percentage Determination of Commercial Quinine Sulphate.—Dr. W. Koppeschaar.—The author refers to the dispute whether crystallised quinine sulphate contains 7 to $7\frac{1}{2}$ or 8 mols. of water of crystallisation. Three methods for the quantitative determination of quinine are discussed, the herapathite method, the separation by means of ether, and the optical method. The first of these processes determines the quinine alone. In skilful hands it gives very accurate results and can therefore be advantageously used for determining the value of commercial quinine sulphate. The separation by means of ether cannot be used for an exact determination of quinine in cinchona barks. The optical method has been found applicable to the analysis of most mixtures of the cinchona alkaloids.

Detection of Chlorides in presence of Bromides and Iodides.—Dr. L. L. de Koninck.—The process most used to show the presence of chlorides when occurring along with bromides and iodides is founded on the production of chromylchloride by the action of sulphuric acid (monohydrated or fuming) and chromic acid upon the chlorides. This process, however, has several defects, and in its stead the author proposes the following:—The solution containing the chlorides, bromides, and iodides is mixed as usual with solution of silver nitrate in slight excess. The precipitate is collected on a filter and carefully washed until the last trace of dissolved silver is removed, *i. e.*, until the last portions of the washing-water are no longer rendered turbid by a solution of potassium bromide. The silver precipitate is then digested in the cold with 4 to 5 times its volume of a 10 to 15 per cent solution of ammonium sesquicarbonate. The clear liquid is decanted through a small filter, the filtrate is received in a test-tube, and a drop of the solution of potassium bromide is added. If the original substance contained a chloride the silver chloride obtained will be, in part at least, dissolved by the ammonium carbonate, and by the addition of potassium bromide to this solution there is formed a precipitate of silver bromide. This reaction is the more sensitive as the ammoniacal solution on account of its small volume is, so to speak, saturated with silver chloride. Thereby that potassium bromide is used instead of nitric acid or potassium iodide as a reagent for silver chloride, we escape the doubt whether traces of silver may have passed into solution. If pure potassium bromide is treated in the manner above described, a slight turbidity is nevertheless produced on adding a drop of potassium bromide to the ammoniacal solution finely obtained. Still there arises no uncertainty, since, under the conditions of the experiment, any perceptible quantity of chlorine suffices to produce a distinct precipitate. If this method is applied to a mixture containing iodates the silver precipitate after filtration and washing must be treated with sulphurous acid, which reduces the silver iodate to iodide. The presence of cyanogen necessitates a modification of the process. The silver precipitate is first heated until the silver cyanide is completely decomposed. If the residue is treated with zinc or cadmium and dilute sulphuric acid a solution is obtained containing chlorine, bromine, and iodine, and which is afresh precipitated with silver nitrate. The presence of sulphur compounds does not interfere.

Determination of Potassium Bitartrate in Crude Argols and Lees of Wine.—F. Klein.—This memoir will be inserted in full.

Note on the Kjeldahl Process for the Determination of Nitrogen.—Dr. Th. Pfeiffer and F. Lehmann.—The authors heat the substance for oxidation with 20 c.c. sulphuric acid (a mixture of 200 c.c. oil of vitriol and 50 c.c. fuming sulphuric acid), with the addition of a little phosphoric anhydride. The soda-lye added before distillation contains 500 grms. sodium hydroxide per litre, and of this 100 c.c. are always used. To prevent bumping a few zinc turnings are added to the liquid. In some cases

the authors, when proceeding as above, obtained a full per cent of nitrogen more than is theoretically possible. This error is due to the circumstance that, on distilling soda-lye with zinc, small quantities of alkali are carried over by the hydrogen evolved, and are reckoned as ammonia. To prevent, or at least minimise, this error, the authors avoid any great excess of alkali, and use as little zinc as possible. They also interpose between the distillation vessel and the condenser a peculiar safety-tube, which they here figure.

Digestion Stove for the Determination of Nitrogen on Kjeldahl's Principle.—Prof. U. Kreusler.—The construction of this apparatus cannot be understood without the figure.

A New Laboratory Apparatus for Working with Exclusion of Air.—Nikolaus von Klobukow.—This memoir cannot be reproduced without the accompanying figure.

An Air-Pump Regulator for Laboratory Purposes.—N. von Klobukow.—This paper requires the three accompanying illustrations.

Reagents for the Analytical Laboratory.—Dr. R. Wollny.—The author proposes that reagents for gravimetric analysis, qualitative or quantitative, should always be prepared of known strengths, and so that equal measures of the solutions may always bear a fixed relation to each other, and that in a given volume of the solution the quantity of the reagent therein contained is known. He has proposed special labels and "pipette bottles" for measuring out the volumes of the solutions used.

A New Method for the Volumetric Determination of Chlorine.—E. Bohlig.—The author depends on the great insolubility of silver oxalate, and its almost instantaneous transcomposition with metallic chlorides in neutral solutions. If hydrochloric acid or a metallic chloride is to be determined a certain volume of the liquid is boiled for some seconds with basic magnesium carbonate, filtered, and an aliquot part of the filtrate when cold (previously diluted if necessary) is shaken up with dry silver oxalate. It is filtered after standing for a short time, and half of the original volume is mixed with strong sulphuric acid and titrated with permanganate, standardised with decinormal oxalic acid, so that each c.c. permanganate represents 0.007 chlorine. The slight solubility of silver oxalate is determined once for all with permanganate, and is deducted according to the volume. The author finds this method advantageous in water-analysis.

Note on the Determination of Carbonic Acid.—Dr. Kratschmer.—The author figures a modification of the absorption apparatus recommended in the sixth edition of "Fresenius's Quantitative Analysis" (vol. i., p. 449).

Bottles for Reagent Sensitive to Light.—A. Gawałowski.—The author recommends bottles of amber-coloured glass, coated over with green, blue, and violet glass.

Determination of Potash.—The author points out in vol. xiv., p. 341, sodiumbioxalate has been erroneously given in place of neutral salt. Bismuth-sodium sulphate mentioned in vol. xxiii., p. 60, as a new reagent for potassa was previously proposed by Carnot (*Comptes Rendus*, 1878, No. 7).

A New Reaction for Titanic Acid.—R. Fresenius.—This paper will be inserted in full.

Determination of Tin in Tin Scoriæ.—R. Fresenius and E. Hintz.—This paper will be inserted in full.

Gas-Analysis under Reduced Pressure.—L. Meyer and K. Seubert.—The authors modify the violence of the explosion, not by admixture with indifferent gases, but by a reduction of pressure and consequent expansion. Their apparatus is described with reference to the accompanying figure.

The Calculation of Gas Analyses.—L. Meyer.—No particulars are given.

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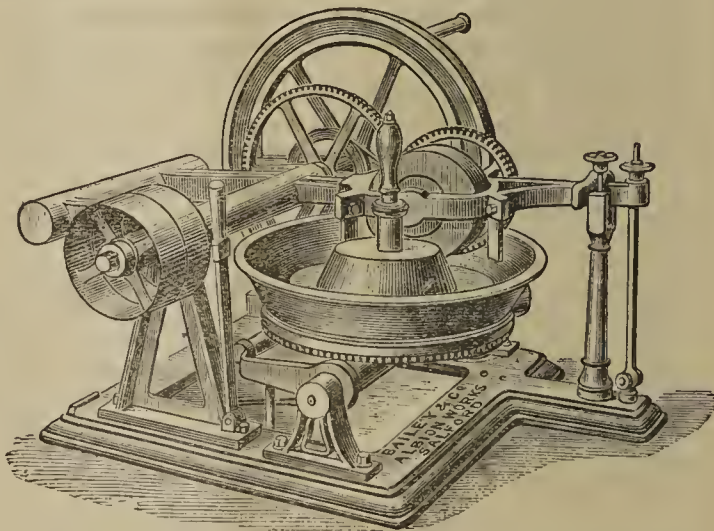
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THE CHEMICAL NEWS.

VOL. LII. No. 1345.

ON THE DETECTION OF IRON, ALUMINIUM, CHROMIUM, MANGANESE, COBALT, NICKEL, CALCIUM, AND MAGNESIUM (AS PHOSPHATES) IN THE PRECIPITATE PRODUCED BY AMMONIA.

By CHARLES L. BLOXAM.

IN the ordinary systematic course of qualitative analysis it is usual, after filtering off any precipitate by H_2S , to peroxidise any iron in the filtrate with HNO_3 , and to add NH_4Cl and NH_3 in excess. The precipitate will usually contain all the Fe_2O_3 , Al_2O_3 , and Cr_2O_3 , with the phosphates of alkaline earths which may be present, together with small quantities of Mn, Co, and Ni which are carried down, chiefly by the Fe_2O_3 . Some analysts recommend the addition of ammonium sulphide, without filtering from the precipitate by NH_3 , in order to bring down the whole of the Mn, Co, Ni, and Zn in the same precipitate. The objection to this course is that, if much iron be present, as is the case in most ores, &c., the large precipitate of sulphide is troublesome to deal with, and if little iron be present, the analyst loses the chance of separating the bulk of the Mn, Co, and Ni from it in the ammoniacal filtrate. Unless the Fe exceed twenty times the weight of the Co, some of the latter will be found in the solution, and Ni is much less easily carried down than Co.

The method usually followed in analysing the precipitate produced by NH_3 is to separate the sesquioxides by their tendency to precipitate as basic salts on boiling their largely diluted, nearly neutral, acetic solutions. This involves a subsequent evaporation of a filtrate containing much saline matter, even if the precipitation of the sesquioxides is completely effected, which is not the case when chromium is present in considerable proportion.

Having found (CHEMICAL NEWS, vol. I., p. 112) the precipitation by sodium phosphate from an acetic solution very successful for separating ferric oxide from manganese, I have endeavoured to apply it in the systematic course.

A solution containing Cr_2O_3 , when mixed with ammonium acetate and acetic acid, gives no permanent precipitate with sodium phosphate unless it is added in sufficient quantity to neutralise the acetic acid; but if the solution be somewhat diluted and boiled, all the Cr is deposited as a bright green precipitate. When Fe_2O_3 is present the ferric phosphate carries down much of the chromium, which imparts a dingy greenish colour to the otherwise creamy-white ferric phosphate. When the iron amounts to ten times the chromium, the latter is entirely precipitated together with the ferric phosphate. Manganese, cobalt, and nickel are not precipitated by sodium phosphate from a solution containing acetic acid, even on boiling; if excess of ammonia be added, and the solution boiled, the whole of the manganese is precipitated as ammonio-phosphate, occasionally accompanied by a little cobalt, but, as a rule, all the cobalt and nickel are retained in the ammoniacal solution.

If calcium or magnesium phosphate be present, together with iron and chromium, the addition of ammonium acetate causes a precipitate of ferric phosphate and chromic phosphate, sometimes carrying down a little manganous phosphate.

The following course can be relied upon for the detection of the metals contained in the precipitate produced by adding NH_4Cl and NH_3 to the filtrate from the precipitate by H_2S .

A. Dissolve the precipitate in as little hot dilute HCl as possible, poured back repeatedly over the filter. Add potash in excess, boil, and filter; examine the precipitate (Ppt. 1) as in B, after washing it thoroughly. To the filtrate add acetic acid in excess, filter off any precipitate (aluminium phosphate), and add ammonia in excess to the filtrate; again filter from precipitated alumina, and add to the filtrate a mixture of MgSO_4 , NH_4Cl and NH_3 , to detect phosphoric acid.

B. Dissolve Ppt. 1 in as little HCl as possible, boil to expel any Cl (indicative of Mn), and cool. Add ammonium acetate (prepared by mixing ammonia with acetic acid in excess) as long as any change is perceptible. If only a slight precipitate be produced, pass on to C without filtering (noting the probable presence of ferric phosphate). If the precipitate be considerable, filter it off, wash it, and examine it (Ppt. 2) as in F.

C. To the filtrate add sodium phosphate. If only a slight precipitate be produced pass on to D without filtering. If the precipitate be considerable, filter it off, wash it, and examine it (Ppt. 3) as in H.

D. Boil the filtrate for a few minutes. If any precipitate is formed it is generally the bright green chromium phosphate; but if Ppt. 3 was not filtered off it may contain a little iron, which may be detected as in H.

E. To the filtrate from any precipitate produced in D add ammonia in excess, and boil for a few minutes. Filter off any precipitate (Ppt. 4), wash it, and examine it as in I. To the filtrate add ammonium sulphide, and boil. Examine the black precipitate for cobalt and nickel by Liebig's potassium cyanide method.

F. Dissolve Ppt. 2 in a little HCl, add sodium carbonate in excess, and boil; wash the precipitate and examine it as in G. To the filtrate add acetic acid in excess, and a drop of ferric chloride to detect phosphoric acid.

G. The precipitate by boiling with sodium carbonate is rinsed off the filter into a small beaker or dish, two or three drops of sodium carbonate added, and a considerable quantity of bromine water: the mixture is boiled and filtered. The ferric oxide is left on the filter, whilst the chromium is dissolved as sodium chromate, recognised by the bright yellow colour of the solution, and the yellow precipitate on adding excess of acetic acid and lead acetate.

H. The precipitates produced in C and D may be examined together as in F, omitting the test for phosphoric acid.

I. Dissolve Ppt. 4 in HCl, add ammonium acetate and enough ferric chloride to produce a pink colour. Boil, filter off the precipitate (ferric phosphate and basic acetate), mix the filtrate with ammonia in slight excess, add a considerable quantity of bromine water, boil, and filter. Examine the filtrate as usual for any Ca, Ba, Sr, or Mg which may have been present as phosphates in the original precipitate.

Any black precipitate produced by bromine is probably MnO_2 , but may possibly contain Co_2O_3 . Dissolve it in HCl, boil, add ammonium carbonate in excess, and boil; MnCO_3 is precipitated, and may be tested by the blowpipe. Cobalt will impart a pink colour to the filtrate.

The analytical process is simpler in execution than in description. So much information is afforded by the colour at different stages that many of the steps may often be omitted. Thus iron, unless present in very small proportion, would be indicated by the red colour of ferric acetate in B. Chromium imparts a green colour to the solution of Ppt. 3 in HCl, when cold, even though the iron present is one hundred times the weight of the Cr. Moreover, chromium is generally detected by the bright green precipitate produced in D. Cobalt is indicated by the pink colour of the ammoniacal solution in E, and, if calcium phosphate be present, by the violet colour of the precipitate.

The method has been tested by applying it to the following mixtures (in grammes):—

- (1). Fe 0.014; Ni 0.016.
Al 0.007; FePO₄ 0.042.
Cr 0.014; AlPO₄ 0.032.
Mn 0.014; Bone-ash 0.082.
Co 0.016; MgNH₄PO₄.6Aq 0.064.

(Approximately 1 atom of each metal and one molecule of each phosphate).

In several analyses of this mixture it was found that—

- (a). All the manganese was present in the precipitate produced by NH₃ in presence of NH₄Cl.
(b). A considerable quantity of Co was contained in the precipitate, but no appreciable amount of Ni.
(c). All the phosphoric acid was precipitated by the NH₃.
(d). The filtrate from the KHO precipitate in A contained all the Al in the state of phosphate, together with much potassium phosphate.

	(2).	(3).	(4).	(5).	(6).	(7).	(8).
Iron—	0.374	0.374	0.374	0.029	0.007	0.004	0.007
Chromium—	0.034	0.0034	0.0003	0.068	0.068	0.068	0.034
	Fe ₁₀ Cr	Fe ₁₀₀ Cr	Fe ₁₀₀₀ Cr	Fe ₂ Cr ₅	FeCr ₁₀	FeCr ₂₀	FeCr ₅
(9).	(10).	(11).	(12).	(13).	(14).	(15).	
Iron—	0.045	0.045	0.045	0.187	0.004	0.037	—
Chromium—	—	—	—	—	0.034	0.003	0.034
Manganese—	0.004	—	0.004	0.002	0.004	0.004	0.004
Cobalt—	—	0.005	0.005	0.002	—	—	—
	Fe ₁₀ Mn	Fe ₁₀ Co	Fe ₁₀ CoMn	Fe ₁₀₀ CoMn	FeCr ₁₀ Mn	Fe ₁₀ CrMn	Cr ₁₀ Mn

When nickel was present, together with iron and cobalt, the ferric hydrate precipitated by NH₃ always carried down the cobalt in larger proportion than the nickel, as would be expected from the greater tendency of cobalt to peroxidise, thus placing it nearer to iron. This difference affords a rough method of detecting nickel in the presence of cobalt. A solution containing 0.005 grm. of nickel and 0.05 grm. of cobalt was mixed with a solution containing 0.887 grm. of ferric iron (about 19 atoms iron to 1 atom of cobalt), and precipitated by NH₃ in the presence of NH₄Cl. The filtrate, mixed with ammonium sulphide and boiled, gave a precipitate which was nearly pure NiS, only a trace of Co being discoverable by the blowpipe.

In the separation of chromium from iron by oxidation with bromine-water, it is necessary to decompose the chromic phosphate by boiling with sodium carbonate, and to filter, because an excess of the carbonate hinders the action of the bromine. A mixture of potassium ferricyanide and potash, when boiled with the precipitated chromic phosphate, readily converts it into potassium chromate, but the presence of the ferro- and ferricyanide in solution hinders the detection of small quantities of chromium. For separating a large quantity of chromium from a small quantity of iron this method is superior to the treatment with bromine.

King's College, London.

The Decolourising Action of Ferric Salts upon Indigo.—L. Margary.—Ferric sulphate decolourises indigo exactly like ferric chloride or potassium ferricyanide. In preparing iron mordants by the action of nitric and sulphuric acids upon copperas, indigo cannot be used to show the disappearance of the nitric acid, as the mordant formed acts itself upon the colouring-matter.—*Journ. de Pharm. et de Chem.*, Vol. xi., No. 12.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from p. 105).

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
|| Following a date signifies publication discontinued.

MÉTHÉRIE, DE LA.

See Introduction aux observations sur la physique [etc.].

MILLON (E.) ET REISET (J.).

See Annuaire de chimie.

127. MISCELLANEA DI CHIMICA, FISICA E STORIA NATURALE. 8vo. Pisa, 1843.

128. MITTHEILUNGEN AUS DEM GEBEITE DER REINEN UND ANGEWANDTEN CHEMIE. Für Fachchemiker, Aerzte, Oeconomen, etc. Als Jahresbericht des Laboratoriums für 18**. Veröffentlicht von V. Kletzinsky. 4to. Wien, 1865, '66.

129. MITTHEILUNGEN AUS DEM LABORATORIUM DER ALLGEMEINEN CHEMIE an der Kais. Kön. technischen Hochschule zu Brünn. 3 nos., 8vo. Wein, 1876.

Reprinted from Sitzungsberichte der K. Akademie der Wissenschaften.

130. MONATSHEFTE FÜR CHEMIE UND VERWANDTE THEILE ANDERER WISSENSCHAFTEN. Gesammelte Abhandlungen aus dem Sitzungsberichte der K. Akademie der Wissenschaften. 5 vols., 8vo. Wein, 1880-'84+

MONITEUR SCIENTIFIQUE DU CHIMISTE [etc.]. See Revue scientifique et industrielle.

131. MONITEUR (LE) DES PRODUITS CHIMIQUES, pour l'industrie, les sciences et les arts, et du matériel de ces industries. Publié par une Société de chimistes et d'industriels. Edmond Rousset, gérant. 14 (?) vols., 4to. Paris, 1871-'84+

132. MONTHLY (THE) MAGAZINE OF PHARMACY, CHEMISTRY, MEDICINE [etc.]. 5 (?) vols. London, 1876-'80+

MONS, J. B. VAN.

See Journal de chimie et de physique; also Journal de chimie pour servir [etc.].

MULDER, G. J.

See Scheikundige onderzoekingen.

MUTER, J.

See Analyst (The).

133. NATURHISTORISCHE UND CHEMISCH-TECHNISCHE NOTIZEN, nach den neuesten Erfahrungen zur Nutzanwendung für Gewerbe, Fabrikwesen und Landwirthschaft. 11 vols., 8vo. Berlin, 1854-'59. Neue Folge. 4 vols. (XII.-XV.), 8vo. Berlin, 1860-'62.||

NICHOLSON'S JOURNAL.

See Journal of Natural Philosophy.

NICHOLS, JOS. R.

See Boston Journal of Chemistry.

134. NORDISCHE BLÄTTER FÜR CHÉMIE. Herausgegeben von Alex. Nic. Scherer. 1 vol., 8vo. Halle, 1817.

Followed by :

- [a] Allgemeine nordische Annalen der Chemie für die Freunde der Naturkunde und Arznei-wissenschaft insbesondere der Pharmacie, Arzneimittellehre, Physiologie, Physik, Mineralogie und Technologie im russischen Reiche. Herausgegeben von Alex. Nic. Scherer. 7 vols. (II.-VIII.), 8vo. St. Petersburg, 1819-'22.

(To be continued).

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

ON THE INFLUENCE OF TEMPERATURE
ON THE HEAT OF DISSOLUTION OF SALTS
IN WATER.*

By WILLIAM A. TILDEN, D.Sc. Lond., F.R.S.,
Professor of Chemistry in the Mason College, Birmingham.

THE experiments described in this paper were undertaken in the hope of obtaining some light upon the vexed question of the condition in which a solid exists when dissolved in a liquid, and were directed more especially towards the investigation of the well-known remarkable phenomena exhibited by sodium sulphate.

Crystallised sodium sulphate melts at about 34° , and at this temperature the salt begins to show signs of dissociation by depositing the anhydrous compound. According to Wiedemann,[†] indeed, indications of change are observable at a few degrees lower. He finds, by observation of the volume of the crystallised salt at different temperatures, that whereas slight expansion occurs from 17° to about 30° , contraction then sets in, at first slowly, then, at 33° to 34° , very rapidly, till the salt melts. The melted salt expands regularly in proportion as the temperature is raised to near 100° . Nicol[‡] has made experiments upon the expansion of solutions of the same salt, and with similar results.

The solubility of sodium sulphate increases rapidly from ordinary temperatures up to 34° , when it attains a maximum. From this point upwards the solubility again diminishes very rapidly to between 40° and 50° , and then less rapidly, till at 100° to 160° it becomes nearly stationary. At temperatures higher than 160° the solubility slowly increases again.[§]

In 1874 it was observed by De Coppet^{||} that heat is developed by contact of water with anhydrous sodium sulphate at temperatures considerably above 34° , at which point the ordinary hydrate is broken up. This circumstance was attributed by Thomsen to the formation of a monohydrate, $\text{Na}_2\text{SO}_4 \cdot \text{H}_2\text{O}$, and he ascribed this composition to the crystals which are deposited on heating a concentrated solution of sodium sulphate, and which had always been believed to be anhydrous. Thomsen's assumption has, however, been shown to be groundless,[¶] and therefore the fact noticed by De Coppet remains without adequate explanation.

Below the temperature of 34° it seems probable that the sodium sulphate dissolved in water is in the state of hydrate, $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$. In what condition is it at temperatures higher than 34° ? In other words, Does the solution contain the usual hydrate or the anhydrous salt, or both?

This is the question which I have endeavoured to attack by comparing the thermal changes attending the act of solution of the anhydrous salt in water at temperatures above this critical point with the corresponding change at temperatures below. Some interesting results have been obtained, but they do not supply a final answer to this question. My few earlier experiments, communicated in a short note to the British Association at Montreal, gave erroneous results, partly because I was then unaware of the existence of the allotropic modifications of anhydrous sulphate of sodium since discovered by Mr. Pickering (*loc. cit.*), and partly from errors of experiments, which have since been corrected.

The apparatus I have used consists of two parts, the calorimeter and the constant temperature bath. The calorimeter is a brass drum, 9 c.m. high and 7 c.m. diameter, having a paddle which works in a socket in the centre of the vessel, and the spindle of which passes

through the lid. At the top of the spindle is a reel, round which passes a silk cord, the ends of which are weighted and drawn over pulleys placed at a little distance on opposite sides. By gently pulling the cord at either end the paddle is made to spin round. Immediately above the blades of the paddle is a wide brass tube perforated with holes, and the bottom of which is immersed in the water, which is placed in the calorimeter. In this tube is placed a thin glass bulb containing the weighed quantity of salt and sealed at the blowpipe. Standing in the tube is a thin brass rod having a fork at the end to act as pulveriser, the top which projects through the lid of the calorimeter being provided with a wooden handle. The thermometer stands in a perforated tube on the opposite side of the calorimeter. The cover of the calorimeter is provided with three holes, one for the stem of the thermometer, one in the centre for the paddle, and the third for the handle of the pulveriser. The vessel is supported on three sharp boxwood points within a covered brass case silvered inside, the space between the calorimeter and the case being about 1 c.m. all round.

The bath employed for maintaining a constant temperature is practically identical with that described by Nicol,* but is provided with a well in the middle, into which fits closely the outer case of the calorimeter. The temperature of the water or oil is remarkably constant, and when the temperature does not exceed 30° a thermometer in different parts of the bath does not vary by more than 0.05° . To assist in maintaining this constancy the bath is covered closely, and is enveloped in thick felt. Three thermometers were used—A, from 8° to 26° C., divided into twentieths; B, from 25° to 50° , and C, from 42° to 76° , both divided into tenths Centigrade, and the temperature could easily be read to 0.005° and 0.1° respectively, or even half this.

The course of an experiment is as follows:—The water having been introduced into the calorimeter, and the thermometer inserted into its tube, the whole is placed in an oven until the thermometer indicates a temperature about half a degree above that to which the bath has been previously heated. The calorimeter is then put into the bath, the cover of the case is put on, and the thermometer read from time to time till the temperature is either quite stationary or is falling steadily at a rate which is recorded, and from which a correction can be introduced into the observed result. The glass bulb is then broken, and the paddle gently worked by one person whilst another reads the thermometer by the telescope. In every case a definite interval (usually one of two minutes) is allowed to elapse before the final reading is taken, not only to allow time for solution, but for the alteration of temperature in the liquid to be imparted to the calorimeter. In those cases in which the calorimeter had been in the bath for some time at a rather high temperature, and there was reason to fear that slight loss had occurred by evaporation, the whole was weighed after the experiment was concluded, and a correction introduced accordingly. The amount thus lost never exceeded a gramme or thereabouts, and as the thermal equivalent of the calorimeter and its contents amounted to 100 grms. and upwards, the result is not appreciably affected.

In the following tables the numbers contained in the column headed "Water equivalent of the calorimeter" include the values of the calorimeter, the glass bulb, the thermometer, and the solution, the specific heat of which is taken generally from Thomsen's numbers.

Three series of experiments were undertaken with sulphate of sodium, and the results are embodied in the three tables, A, B, and C.

For A the salt had been heated to redness, not to fusion, about a fortnight before.

For B the salt had been heated to redness one day before.

For C the precipitated salt had been dried at 120° .

* A Paper read before the Royal Society, June 18th, 1885.

† *Pogg. Ann.*, 1882, 561.

‡ *Ber. Deut. Chem. Ges.*, xv., 1931 b.

§ Tilden and Shenstone, *Phil. Trans.*, 1884, I., 23.

|| *Comptes Rendus*, 79, 167.

¶ De Coppet, *Ber. Deut. Chem. Ges.*, xii., 248, and Pickering, *Journ. Chem. Soc.*, 1884, 689.

* *Phil. Mag.*, 1883, 339.

These varieties were taken on account of the differences in the heat of dissolution of sulphate of sodium which have been observed by Mr. Pickering (*loc. cit.*).

Sodium Sulphate, Na_2SO_4 , in 100 molecules of Water, or 142 parts in 1800 parts.

Weight of salt used 6.311 grms.

Weight of water used 80.000 "

Specific heat of solution $\text{Na}_2\text{SO}_4\text{H}_2\text{O} = 0.927$.

No. of expt.	Water equiv. calorim., &c.	Temperature.		Correc- tion.	Total rise.	Molecular heat of dissolu- tion.
		Before solution.	After solution.			
SERIES A.						
1	110.7	33.46	34.00	+0.006	0.546	1360
2	110.7	33.30	33.86	+0.010	0.570	1419
3	110.6	33.24	33.79	+0.005	0.555	1381
4	110.7	34.97	35.55	0	0.580	1444
5	110.6	34.90	35.49	0	0.590	1468
6	110.6	35.01	35.58	0	0.570	1418
7	110.7	35.41	35.93	+0.010	0.530	1320
8	110.7	39.70	40.30	0	0.600	1494
9	110.7	39.60	40.20	0	0.600	1494
10	110.7	44.07	44.68	-0.010	0.600	1494

SERIES B.						
11	110.7	31.19	31.70	0	0.510	1270
12	110.6	31.50	32.01	0	0.510	1269
13	110.7	44.28	44.98	-0.016	0.684	1703
14	110.7	44.755	45.490	0	0.735	1830
15	110.7	44.57	45.20	-0.01	0.620	1544
16	110.7	45.01	45.71	+0.009	0.709	1766
17	110.6	63.51	64.30	+0.022	0.812	2020
18	110.7	67.80	68.69	0	0.890	2216

SERIES C.						
19	110.7	31.60	32.06	0	0.460	1146
20	110.6	31.54	32.00	0	0.460	1146
21	110.7	45.00	45.55	0	0.550	1369
22	110.8	44.98	45.50	+0.006	0.526	1311
23	110.7	60.10	60.84	+0.01	0.750	1869
24	110.7	64.20	64.94	+0.01	0.750	1869
25	110.6	64.20	64.96	+0.052	0.812	2020

Mean Results.

No. in table.	Temp. approx.	Heat of dissolution.		
		A.	B.	C.
11, 12	31°	—	1270	—
19, 20	32	—	—	1146
1, 2, 3	33	1387	—	—
4, 5, 6, 7	35	1412	—	—
8, 9	40	1494	—	—
10A, 13B	44	1494	1703	—
14, 15, 16B, 21, 22C	45	—	1713	1340
23	60	—	—	1869
17B, 24, 25C	64	—	2020	1945
18	58	—	2216	—

From these figures it appears that although the manner in which the salt has been prepared influences the result very notably, yet in each series, comparing together the effects of dissolving the same kind of anhydrous sodium sulphate, the heat of dissolution increases progressively with rise of temperature. That this would be the case might be predicted by applying the principle originally indicated by Person,* and since discussed by Berthelot† and by Thomsen,‡ and embodied in the general equation $Q_r = Q_t + U - V$, where Q_r and Q_t are the quantities of heat evolved in the act of solution at the temperatures T° and t° , and U represents the sum of the capacities for heat of the salt and the water, and V represents the

capacity of the solution between the temperatures T° and t° .

The salt A must be regarded as being in the most stable condition of the three, and the following comparison of the numerical values of the thermal change observed and calculated applies to the A series of experiments:—

$$U = (18n + C)(T - t).$$

n is the number of water molecules.

C is the molecular heat of the salt.

$$V = (18n + K)(T - t).$$

$$C = 3.22 \text{ (Kopp).}$$

$$18n + K = 1815 \text{ (Marignac).}$$

Take Q_t at $34^\circ = 1400$, which is the mean of numbers given above for 33° and 35° ,

Then $Q_r = 1503$ when $T = 40^\circ$.

$= 1537$ when $T = 42^\circ$.

$= 1572$ when $T = 44^\circ$.

From 40° to 44° observed 1494.

There is not much difference here, but the observed is less than the calculated number.

Carbonate of sodium was next examined on account of its close resemblance to sulphate of sodium in water of crystallisation, melting-point, and solubility.

Sodium Carbonate, Na_2CO_3 , in 100 molecules of Water, or 106 parts in 1800 parts by weight.

Weight of salt used 5.005 grms.

Weight of water used 85.0 "

Specific heat of solution $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} = 0.933$.

No. of expt.	Water equiv. calorim., &c.	Temperature.		Correc- tion.	Total rise.	Molecular heat of dissolu- tion.
		Before solution.	After solution.			
26	116.2	21.85	24.37	+0.075	2.595	6388
27	116.3	21.80	24.25	+0.058	2.508	6177
28	117.5	22.545	25.050	+0.1075	2.6125	6485
29	117.4	22.39	24.82	+0.079	2.509	6238
30	116.2	35.60	38.40	0	2.800	6887
31	116.2	35.28	38.08	0	2.800	6887
32	116.2	35.70	38.50	0	2.800	6887
33	116.3	38.18	40.90	+0.004	2.724	6708
34	116.3	38.97	41.60	+0.112	2.742	6753
35	116.1	43.55	46.30	+0.015	2.765	6785
36	116.3	50.40	53.16	+0.020	2.780	6846
37	115.1	55.25	58.08	0	2.790	6783
38	114.9	54.73	57.58	0	2.850	6923
39	116.1	54.60	57.50	-0.002	2.898	7128
40	116.2	54.30	57.18	0	2.880	7067
41	115.1	56.00	58.875	0	2.875	7004

The carbonate of sodium used in these experiments had been heated to redness, but at times which varied from a few hours to several days. Some of the irregularities in the numbers may be not improbably due to this circumstance. But the mean results show on the whole an increase in the heat of dissolution with rise of temperature.

Experiment number.	Temperature approximate.	Mean heat of dissolution.
26 to 29	22°	6322
30 " 33	35—40°	6842
34 " 35	40—45°	6769
36 " 41	50—55°	6958

Calculated from the figure for $22^\circ = 6322$, taking $C = 26.1$ (Kopp), $18n = K = 1778$ (Thomson), $T = 55^\circ$.

$Q_r = 7909$, which is much higher than 7128, the greatest observed value at 55° — 56° .

(To be continued.)

The Manurial Value of Freshly-fallen Tree-leaves
—Prof. Emmerling, Dr. Loges, and Head-Forester Emeis.
—Beech, oak, and birch leaves contain only 2 to 2.3 per cent of utilisable mineral matter; plane up to 4; poplar and willow 5 to 5.7 per cent.—*Biedermann's Central-Blatt.*

* *Ann. Chim. Phys.*, [3], xxxiii., 449.

† *Ibid.*, [4], vi., 329.

‡ "Thermochemische Untersuchungen," I.

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Prof. CHAS. E. MUNROE, U.S.N.A.

(Continued from p. 101.)

ON page 455, vol. viii., *Proc. Naval Institute*, reference was made to the fact that the British Dynamite Company are now using iron tanks for transportation of their sulphuric acid in the place of the fragile glass carboys formerly used. In a paper on "The Appointment of a U.S. Commission of Tests of Metals," *Trans. Am. Soc. Mechanical Eng.*, 1882, p. 8, Dr. Thomas Egleston points out that instead of the general belief, that the presence of sulphur and phosphorus in iron is always objectionable, being true, it is, on the contrary, found that for certain uses it is highly desirable, and that among others it has been found that the parting pots used in mints, formerly made of platinum at enormous cost, can be advantageously replaced by iron containing a certain percentage of either phosphorus or silicon, which will resist the action of acids even better than the more expensive metal. And if some means of casting ferro-silicon containing from ten to fifteen per cent of silicon could be found it would be invaluable, since it has been shown that this substance is completely insoluble in aqua regia.

In connection with the note on page 311, vol. viii., the following abstract from the *Danbury (Ct.) News* found in the *Boston Journal* of July 30th, 1883, may prove interesting:—

"A carboy of nitric acid broke in a car on the New York City and Northern road on its way to Danbury, Sunday evening. On its arrival here at 8 o'clock, a blue flame was seen to issue from its roof by Frank Wheeler, an employé of the New England Company. Station Agent Pearce was notified, who made an examination and learned the cause of the trouble. He and several others immediately set to work to empty the car, a difficult and dangerous task, as the inside of the car was full of the destroying gas. One of the helpers was Harry N. Baker, in the employ of the New England Company. He went home after the car was cleared and was attacked with nausea. He was at work on Monday morning, but shortly was taken ill and returned home, where he now lies in an unconscious state, and with no hope of his recovery. The physicians in charge say his lungs are coated with the poisonous gas."

On page 287, vol. ix. of the *Proceedings*, a resumé of Abbot's report on Submarine Mines is given. Gen. Abbot has now issued Addendum I. to this report, embodying the results obtained with tonite, California gun-cotton, and rackarock. The tonite had been manufactured in the United States for about a year by the Tonite Powder Company of San Francisco, under patents assigned by the Cotton Powder Company, Limited, of London, when in the summer of 1882 samples were procured for trial at Willet's Point. The shipment was made on the Pacific Railroad. The works of the company, near Stege station on the Central Pacific, are reported to have a capacity of twenty tons monthly, and it is understood that similar works are to be erected in the East. The Standard tonite made by the company consists of 52.5 parts of gun-cotton and 47.5 parts of nitrate of baryta; but for special purposes, and by request, a part of the latter is sometimes replaced by potassium or sodium nitrate.

Two varieties of the standard explosive were received—one dry in compacted cartridges, and the other damp in bulk. The damp as sent contained 18 per cent of moisture, but when received it held but 13.5 per cent. The uncompressed damp tonite was detonated with dry tonite or gun-cotton. The relative efficiency in a horizontal plane as compared with dynamite No. 1 was found to be 0.81 for

the dry compressed state and 0.85 for the other, giving as an average value 0.83. The explosive therefore takes rank just below gun-cotton (0.87). The result is not unlike what might be anticipated from the chemical composition of these two explosives, and it is evident that the substitution of a portion of nitrate of baryta tends rather to reduce than to increase the normal intensity of action of gun-cotton, pound for pound, when fired under water.

The Tonite Powder Company of San Francisco also manufactures gun-cotton by a process which appears from their circulars to be essentially that of Prof. Abel—omitting the compression into cartridges. It was regarded as desirable to test this product at Willet's Point in the usual manner, to learn how it compares in strength with that made in England. A sample was accordingly procured with the tonite in the summer of 1882. The explosive was delivered damp in the state of loose powder, which when dry became a fine white dust. The following statement respecting it was received from Mr. W. L. Oliver, General Manager of Company:—

"Lot No. 3.—This is 120 pounds gun-cotton (pulverised) containing 24 per cent of moisture. This lot of gun-cotton gave by assay 89.60 per cent insoluble trinitro-cellulose and 10.40 per cent soluble gun-cotton. This is not quite up to our average, which is about 93 per cent, owing to the acid of late being rather inferior; but nevertheless the gun-cotton is good, and is 7 per cent above the standard required by the British Government. The test for purity and acidity from two samples stood 246° and 250° F. for 28 minutes, the British Government standard being 150° for 10; and these samples, subjected to a long and steadily increasing temperature, stood 358° and 360° before it flashed, and a fresh sample started at 200° stood 364°. Such gun-cotton will keep unaltered for many years in any climate."

This gun-cotton was shipped across the country packed in a barrel. To determine whether, when actually tested, the explosive retained the full 24 per cent of moisture, a sample of 400 grains was withdrawn from the bottom of the mass and desiccated to dryness. The loss proved to be 80.6 grains, or only 20 per cent. These figures were used in estimating the charges in preference to those furnished by the company, because some loss of moisture was to be expected under the circumstances. The firing test showed this gun-cotton to be not inferior in explosive intensity to the best English manufacture, but in the form furnished it was so bulky that very solid packing was necessary to force 4.2 pounds into a No. 2 can, which will readily receive 10 pounds of dynamite in loose powder. This bulk would be a fatal objection for use in ground mines, but would be perhaps an advantage in buoyant torpedoes.

The Rackarock, supplied by the Rendrock Powder Company of New York, was brought to Gen. Abbot's notice in the winter of 1882, by one of the manufacturers. It consists of a solid, composed mainly of potassium chlorate, in fine powder, given a reddish tint by some colouring matter, and of an oily liquid, having the strong, bitter almond smell characteristic of nitro-benzol. These compounds, neither of which is explosive by itself, are combined before use by immersing the solid in the liquid for a few seconds until an increase in weight of about one-third is effected by absorption. The solid is supplied in the form of loosely-packed cartridges of different sizes, put up in bags closed at each end. The combination of the ingredients is effected by means of an open basket of wire to receive the cartridges, which is suspended from a spring balance, and dipped in a galvanised iron pail containing the fluid. A little attention to the time of immersion renders the absorption fairly uniform. The explosive, when prepared in this manner, is a compact red solid, having a specific gravity of about 1.7. It decrepitates with difficulty when hammered on an anvil, but hardly ignites on wood. A fuse containing 24 grains of fulminating mercury fails to explode a cartridge unconfined or loosely confined. Even if it be compacted in an auger-

* From the *Proceedings of the U.S. Naval Institute*.

As it is proposed to continue these notes from time to time, authors, publishers, and manufacturers will do the writer a favour by sending him copies of their papers, publications, trade circulars, or expert testimony in infringement cases.

hole in a log and tamped with mud the explosion is only partial. A cartridge struck by a bullet from a Springfield rifle flashes but does not detonate. Ordinary friction seems to have little tendency to cause explosion. These facts show it to be quite safe to handle even when ready for use, and it has given excellent results in rock-blasting under General Newton at Flood Rock. Its peculiar chemical composition gives rackarock the interest of novelty among modern high explosives, and it has accordingly been tested with special care to discover the intensity of action of which it is capable when fired under water. Two fluids were supplied for the trials—the usual one consisting essentially of nitro-benzol; and the other, of a special preparation consisting of the same saturated with picric acid (12 to 16 per cent according to the quality of the solvent). The explosives prepared by absorbing these fluids by the solid are designated as "rackarock" and "rackarock special."

The results of the firing tests showed that rackarock, fired under water, gives a relative efficiency in the horizontal plane of 0.86, being nearly equivalent to gun-cotton, and a study of the results proved that there is no difference in the intensity of action between rackarock and rackarock special, which exceeds the range of variation with either of them, but there was a considerable variation with each of them. That this should be so in a mixture of which the ingredients are combined by the rough method described above is not surprising. Moreover, nitro-benzol itself (formed by treating crude benzene with fuming nitric acid) is certainly subject to important variations in chemical composition due to its impurities; and the same is probably true of the solid as supplied in the trade cartridges.

The anomalous variations noted were confined to the firing of two days. It is to be regretted that the causes which produced the excessive pressures could not be detected, for if the peculiar conditions corresponding to the greatest intensities of action could always be fulfilled this explosive would take rank with explosive gelatin itself instead of with gun-cotton for use under water.

Gen. Abbot concludes that "rackarock possesses the merits of high intensity of action, unusual density, absolute safety in handling and storage (components unmixed), and little cost; on the other hand, under the conditions of my tests, an exceptionally strong detonating primer is essential to develop its full power. Experiment alone can determine whether this defect be equally marked when the charges are confined in drill holes in solid rock." It

will be observed that rackarock belongs to the class of explosives invented by Dr. Sprengel, and noted on page 670, vol. viii., of the *Proceedings of the U.S. Naval Institute*.

For comparison of the relative efficiency of explosives I add a table taken from Gen. Abbot's "Submarine Mines," p. 110.

Through the courtesy of Col. V. D. Majendie, C.B., H.M. Chief Inspector of Explosives, we are in receipt of the "Seventh Annual Report of H.M. Inspectors of Explosives," and of several special reports of the circumstances attending some recent cases of explosion. The number of factories (exclusive of "toy" fireworks factories) is now one hundred. The following explosives have been added to the licensed list:—

E. C. Sporting Powder.—Consisting of rifle gun-cotton, with the addition of colouring-matter consisting of aurine (free from mineral acid) dissolved in a solvent composed of ether, alcohol, and benzoline.

E. C. Rifle Powder.—Consisting of rifle gun-cotton, with the addition of colouring matter consisting of picric acid (free from mineral acid) dissolved in a solvent composed of ether, alcohol, and benzoline.

Asphaline No. 1.—Consisting of a mixture of chlorate of potash and bran, as hereinafter defined, with or without an admixture of one or more of the following ingredients, viz., nitrate of potassium, sulphate of potassium, paraffin oil, paraffin, ozokerit (such paraffin oil, paraffin, and ozokerit to be free from mineral acid), soap, fuchsine; such mixture to contain not more than 54 parts, by weight, of chlorate of potassium, and 4 parts, by weight, of nitrate of potassium and sulphate of potassium, or either of them, to every 42 parts, by weight, of bran.

Bran, consisting of wheat bran or barley bran, thoroughly cleansed and reasonably free from flour.

Asphaline No. 2.—Consisting of asphaline No. 1, as above described, with the addition of nitrate of potassium in such proportion that the total amount of nitrate of potassium present shall not exceed 25 parts, by weight, in 100 parts, by weight, of the finished explosive.

Spon's Electric Fuses.—Consisting of a case of metal, wood, paper, or other suitable material, containing two or more insulated wires, the terminals of which are (a) imbedded in a charge not exceeding 5 grains of one or other of the priming compositions (1), (2), (3), hereinafter specified, or (b) connected by a bridge of fine wire, composed of a platinum alloy, steel, or other suitable material, the said bridge being imbedded in a charge not exceeding 10 grains of one or other of the priming compositions (4), (5), hereinafter mentioned.

Priming composition (1), chlorate of potash and sulphide of antimony, with or without powdered carbon.

Priming composition (2), chlorate of potash, sulphide of antimony, and phosphide of copper.

Priming composition (3), chlorate of potash, sulphide of copper, and phosphide of copper.

Priming composition (4), gun-cotton thoroughly purified.

Priming composition (5), gun-cotton thoroughly purified, chlorate of potash, and powdered galls.

Spon's Electric Detonator Fuses.—Consisting of electric fuses, as above described, and having attached thereto a detonator, as defined by an Order in Council made under the 106th section of the Act.

Hunter's Patent Miners' Fuses.—Consisting of a cylindrical tube of paper, varnished or coated with a suitable waterproof solution, and filled with gunpowder, in the proportion of not more than 1 lb. of gunpowder to every 500 fuses, the paper tube being closed at both ends, and having one end primed with a solution of nitrate of potassium or nitrate of sodium, or with melted sulphur, with or without nitrate of potassium.

Miners' Squibs.—Consisting of a tube of paper, or other suitable material, partly filled with gunpowder, in the proportion of not more than 1 lb. of gunpowder to every 500 squibs, and having one end closed with a plug of wax, or

Relative Strength of Explosive Compounds Fired under Water.

Explosive.	Percentage of nitro-glycerin.		Relative intensity of action.		
	Value of E.	Down-ward. $\theta = 0^\circ$.	Horizon-tally. $\theta = 90^\circ$.	Up-ward. $\theta = 180^\circ$.	
Dynamite No. 1* ..	75	186	100	100	100
Gun-cotton	—	135	81	87	91
Dualin	(?)	232	116	111	108
Rendrock	20	101	67	78	84
"	40	160	91	94	95
"	60	166	93	95	96
Dynamite No. 2. ..	36	120	75	83	88
Vulcan powder No. 1	30	99	66	78	83
" .. No. 2 ..	35	114	72	82	86
Mica powder No. 1	52	119	74	83	87
" .. No. 2 ..	40	46	39	62	73
Nitro-glycerin ..	100	111	71	81	86
Hercules No 1 ..	77	211	109	106	105
" .. No. 2 ..	42	118	74	83	87
Electric No. 1.. ..	33	67	51	69	77
" .. No. 2.. ..	28	43	38	62	72
Designolle	0	65	50	68	77
Brugere	0	110	71	81	86
Explosive gelatin ..	89	259	125	117	113

* Standard of comparison.

other suitable material, and the other end closed by being twisted, and such twisted end being coated with sulphur or not so coated.

Sound Signal Rockets.—Consisting of a signal rocket having fitted in the head thereof one or more charges of tonite or cotton powder, as hereinafter described, and with or without a layer of compressed gunpowder made of sulphur (free from acid), saltpetre, and charcoal, between the said charges, and having imbedded in the said charges one or more detonators as defined by an Order in Council, made under the 106th section of the Act, such detonators to contain above the fulminate a substantial layer either of strongly compressed mealed gunpowder or of a composition made of two or more of the following ingredients, viz., saltpetre, sulphur (carefully washed), realgar, antimony, gunpowder. The said tonite to consist of gun-cotton thoroughly purified, mixed, or incorporated with a nitrate or nitrates.

Distress Signal Rockets.—Consisting of sound signal rockets, as above described, with the addition in the head of the rocket of one or more stars composed of two or more of the following ingredients, viz., saltpetre, sulphur (carefully washed), realgar, antimony, gunpowder.

The name of the explosive designated as *Liverpool Cotton Powder* or *Potentite* was changed first to *Potentite Cotton Powder*, and subsequently to *Potentite*. *Potentite* (which is nitrated gun-cotton) is manufactured by the *Potentite Co.*, at Melling. Certain specimens of their product were found to be so impure that they were warned.

The importance of putting dynamite in waterproof envelopes, for transportation, is illustrated in the case of the sinking of a barge, where the water reached the dynamite and expelled the nitro-glycerin. Again, in 1882, a case of dynamite was being conveyed across the Duddon Sands. The driver of the cart, trying to make a short cut, got into a quicksand, when the water reached the dynamite and caused the exudation of a large quantity of nitro-glycerin.

A new illustration of the failure of prohibition to prohibit is the following:—The railway companies have refused to carry dynamite and some other explosives of that class under any conditions, notwithstanding the remonstrances of the Inspectors of Explosives. Hence it is not surprising to learn that an agent of the Nobel's Explosive Co. was found to have carried no less than 300 lbs. of blasting gelatin on a passenger train from Newcastle to London, across London in a cab, and thence by rail to Whitstable. The explosive was packed in soft leather bags, a portion of them being taken in a smoking-car, and the rest as ordinary passenger luggage in the van.

The importations of dynamite for the year amounted to 1,008,050 lbs. With two exceptions this dynamite satisfied the required tests. The first was a cargo of 22,200 lbs., from Krebs and Co., of Cologne, made from very imperfectly purified nitro-glycerin. The second, of 75,000 lbs., from Nobel's Explosive Co., Hamburg, was made of nitro-glycerin of satisfactory purity, but the kieselguhr was strongly and dangerously acid. An importation of "Forcite" from Spain was prevented, as examination showed it to be an explosive which had never been examined or tested in England, and of whose properties the inspectors were ignorant. The importation of fulminate of mercury amounted to 12,400 lbs., and of detonators to 1,075,000 lbs.

The report of Dr. Dupré, chemist to the Home Office, shows that the blasting gelatin submitted to him was in every case rejected, as showing a tendency to exude nitro-glycerin, while in addition, in some cases, the cartridges were of a soft or semi-fluid character, which became very marked at 80° F., thus defeating the main object of its manufacture, namely, the conversion of a *liquid too dangerous* to use on account of its being a *liquid* into a *solid*, comparatively safe explosive, *safe because it is solid*.

Samples of coloured fires and fireworks were examined, owing to an accident at Stoke, and it is stated that the

presence of sulphur in a chlorate mixture, even when the sulphur has been carefully washed, is a source of danger. Mixtures containing sulphur and a chlorate are exceedingly sensitive to percussion and friction. It is recommended that potassium perchlorate be substituted for the chlorate, as suggested by a German periodical. The sensitiveness to percussion and friction is thus diminished, while the brilliancy is increased. Experiment showed that a 1-lb. weight falling 10 to 12 inches exploded a mixture of potassium chlorate and sulphur, while a fall of the same weight through 18 to 20 inches was required to explode a similar mixture of perchlorate. Moreover, while the chlorate mixture exploded completely at the first or second blow, it required from five to seven blows to entirely explode the perchlorate mixture. The substitution of the perchlorate would also, probably, diminish the danger of spontaneous ignition of sulphur mixtures, since not even oil of vitriol decomposes perchloric acid.

Experiments made with mixtures of filings or borings of iron or steel with sulphur showed that when moistened with water and surrounded by bad conductors of heat, or in insufficient mass, the temperature rose rapidly, much steam was evolved, and the mixture became in some cases red-hot. This would seem to show that Gerbe mixtures were liable to spontaneous ignition, but in fact the danger is believed to be slight, since the iron borings used are generally very coarse, and since charcoal and nitre are also added. The points of contact of iron and sulphur are therefore limited, in consequence of which the amount of chemical action which can take place in a given time is but small, and but little heat is evolved. In several experiments with recently-made Gerbe mixtures the maximum elevation after moistening was 5° F. When, however, the coarse iron borings were extracted from this mixture by a magnet, and replaced by an equal weight of fine filings, the temperature rose in a few hours as much as 45° F. This would not be enough to endanger the stability of the mixture, but would seriously endanger the safety of a star of sulphur and a chlorate imbedded in it. Iron filings and nitre when moistened likewise increased in temperature with oxidation of the iron and reduction of the nitrate to nitrite. The action, though beginning very soon, is far from energetic, and the rise in temperature is only 5° F.

The influence of temperature on the sensitiveness of dynamite to percussion was tested, showing, as was to be expected, that warm dynamite was more sensitive than cold. One grain of dynamite, at a temperature of 60° F., required a fall of a one-pound steel weight though 18 ins. to explode it, while similar quantities at a temperature of 200° F. were exploded by the same weight falling through 9 inches. Similar differences had previously been found with gun-cotton and Schultze gunpowder.

In analysing an impure nitro-cellulose, the insoluble residue, after extraction with alcohol and ether, exploded spontaneously while drying in the water-oven.

Experiments on the inflammability of moistened tonite showed that with 8 per cent of moisture tonite could be set fire to and would continue to burn. With 10 to 11 per cent it is unflammable. This is considerably less than is necessary for pure gun-cotton, which requires from 18 to 20 per cent.

Two new explosives were examined—asphaline (given above) and virite. Of the latter there were two kinds. Virite No. 1, a mixture of nitro-glycerin, potassium nitrate, and charcoal, passed all the tests successfully. Virite No. 2, containing sodium nitrate in place of potassium nitrate, failed to hold the nitro-glycerin under all the conditions of the tests.

This report contains an admirable summary of the accidental and intentional explosions which have occurred during the year, and much other information to be referred to hereafter.

Special Report No. 48, January 19, 1883, by Colonel V. D. Majendie, is "On Two Explosions at the Factory of the Explosives Company (Limited), at Pembrey Burrows,

Carmarthenshire." The license for this company was granted July 25, 1882, after the factory had been previously inspected by Col. Majendie and Capt. Cundill. The process employed for making the nitro-glycerin was that invented by Boutmy, and which has been in operation at Vonges since 1872. The license permitted the nitrating of 1500 lbs. of glycerin at one charge. The first explosion took place on the 11th of November, 1882, in the converter. The nitration had been started the day before, and at the time of the accident all but 500 lbs. or 600 lbs. of the nitro-glycerin had been removed. The men then drew off the acid until the remaining nitro-glycerin reached the lower tap. Several vessels of this nitro-glycerin were then drawn off, and while the men were busy storing these vessels in another room, the nitro-glycerin left in the converter exploded. It was stated by a workman, who left the building about five minutes before the explosion, that the fumes from the nitro-glycerin were quite exceptional, and that they had nearly choked him as he drew it off. Colonel Majendie finds the cause to be due to violent chemical action established through the decomposition of the nitro-glycerin by the acid present, and cites several previous cases of explosion believed to be due to the same cause. It is noticeable, however, that in all the cases cited, where details are given, it is shown that the action was super-induced by foreign matter, such as water, straw, and the like, coming in contact with the acid mixture, and in the case under consideration the apparatus was so constructed that it was possible for foreign matter to get into the converter. In addition, Dr. Dupré reports that the glycerin used at Pembrey was impure and not well adapted for the manufacture of nitro-glycerin. It had a rather dark colour, a feebly acid reaction, and gave a strong precipitate with nitrate of silver. When mixed with strong sulphuric acid it became very dark and evolved a disagreeable odour. It contained:—

Fatty acids, about	0.5 per cent
Fat	0.3 "
Chlorine in form of chlorides ..	0.15 "
Water	5.00 "

Besides, no precautions were taken to secure nitric acid free from nitrous acid. While the presence of strong acid will cause the decomposition of pure nitro-glycerin, as has long since been pointed out, it does not seem necessary to look for other causes when we find, as in this case, that the materials employed in the manufacture were impure.

After describing the Boutmy process as used at Vonges, Colonel Majendie states that it "will be found more fully and elaborately explained" in the *Proc. United States Naval Institute*, v, 5, 1879. In criticising, however, our omitting to point out the weaknesses of the process, he mistakes a narration for advocacy, and overlooks the fact that the source of the information is quoted.

The second explosion at Pembrey occurred during the thawing of frozen dynamite; and, while the cause is obscure, it is thought to have been due to the falling of a zinc scoop or zinc tray into a metal-lined box containing dynamite, which was probably warmed from the thawing process. Seven persons were killed and one wounded in this explosion, while no one was injured in the first explosion.

(To be continued.)

The Alloys of Cobalt and Copper.—M. Guillemin.—The alloys of copper and cobalt have a red colour and a fine silky fracture, like that of pure copper. They have a remarkable degree of ductility, malleability, and tenacity. They can be forged and rolled hot, but cannot be tempered. These alloys are obtained by melting in a crucible metallic copper and cobalt, under a flux composed of boric acid and wood charcoal. The tenacity of these alloys is much greater than that of pure copper.—*Comptes Rendus*, vol. ci., No. 6.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 6, Aug. 10, 1885.

Instrument for Measuring the Thermic Intensity of the Solar Radiation.—A. Crova.—The author proposes to register the indications of an actinometer giving the thermic intensity of the solar radiation, this apparatus receiving the solar radiations directly, *i. e.*, without the interposition of any transparent plate and being secured against the disturbing action of the wind. The registering actinometer consists of a thermo-electric element inclosed in a slender brass tube. One of the soldered points is in the dark, and the other receives a bundle of solar rays falling normally to its blackened surface in the axis of the tube. This tube is fitted with 5 aluminium diaphragms, with apertures progressively decreasing until the last, which is 4 m.m. in diameter, and placed at suitable distances. This tube is mounted on an equatorial movement which keeps its axis in the direction of the solar rays. Though freely exposed to the sun the actinometric disc does not receive the action of air-currents; there is produced here a phenomenon analogous to that of Deleuil's free piston-machine. The disc only receives the sun upon a small part of its surface, but, in consequence of Peltier's phenomenon, the effect is the same as if the quantity of energy contained in the right section of the solar bundle were uniformly diffused over its surface. The two extremities of the element and the points of junction of the wires are soldered galvanoplastically by a deposit of copper to a circuit connected with a galvanometer placed in a dark chamber. The actinometer mounted upon its movement is placed on the roof. The indications of the mirror galvanometer are registered photographically by an arrangement which, with some modifications is identical with that used by Mascari for registering terrestrial magnetism and atmospheric electricity.

The Critical Temperatures and Pressures of Certain Vapours.—C. Vincent and J. Chappuis.—The authors give the critical pressures and temperatures of ethyl chloride, and of a series of homologous bodies comprising ammonia and the three methylamines. The critical point for ammoniacal gas is 131°, and the corresponding pressure is 113 atmospheres. For mono-methylamine, dimethylamine, and trimethylamine the critical points are respectively 155°, 163°, and 160.5°, the corresponding pressures being 72, 56, and 41 atm.

Oxidation Products of Charcoal by the Electrolysis of an Ammoniacal Solution.—A. Millot.—The author has indicated in a former note that on using charcoal as positive electrode and a plate of platinum as negative electrode in an ammoniacal solution we obtain in some time a liquid of a deep black colour. The black liquid, if mixed with a mineral acid, is decolourised, and deposits a black matter containing carbon, oxygen, hydrogen, and nitrogen, the percentage composition of which has been already indicated. This matter has the greatest resemblance to the ulmic compounds. If the black solution is evaporated in the water-bath it becomes acid, and the black matter is precipitated. On evaporating to dryness and taking up in hot alcohol the black matter remains insoluble, and a yellow alcoholic solution is obtained. This liquid, if evaporated to a syrupy consistence, deposits a nitrogenous substance of a slight yellow colour, which is filtered off. This matter is soluble in boiling water, to which it gives an acid reaction, and is precipitated on cooling. This operation is repeated several times until there is no longer obtained a deposit. Finally, on evapo-

rating the filtrate we obtain a crystalline deposit which is separated from the non-crystallisable mother-liquids. This crystalline matter, after being purified by repeated crystallisations from water and alcohol, has been analysed. Its composition is exactly that of urea, and an examination of its nitrate and oxalate proves it to be pure urea. The non-crystallisable liquid is acid and will be further examined; it does not present the properties of mellitic acid and its derivatives, as was announced by Bartoli and Papasogli. The black matter, when oxidised with sodium hypochlorite, is transformed into the nitrogenous substance, soluble in boiling water, as mentioned above, without giving rise to mellitic acid. The charcoal employed was obtained from sawdust charred in retorts, and purified with chlorine. The battery was composed of eight Bunsen elements, large size. In eight days the electrolysis of 0.5 litre of ammonia diluted with an equal volume of water yielded 6 to 8 grms. of the black matter and 1 gram. of pure urea.

The Transformation-Heat of Chromous into Chromic Chloride.—M. Recoura.—One mol. of chlorine, in fixing itself upon 2 mols. chromous chloride, evolves a quantity of heat greater than that given off when chlorine becomes fixed upon most other elements.

Crystallographic Characters of the Substituted Derivatives of Camphor.—P. Cazeneuve.—The substitution in camphor of a mono-atomic element for hydrogen completely modifies its crystalline form; there is hence no crystalline equivalence between hydrogen and the mono-atomic element substituted. Chlorine, bromine, iodine, cyanogen, and the radicle NO_2 seem to possess such a crystalline equivalence,—that is, they are capable of replacing each other mutually in a compound without completely modifying its crystalline form. Nevertheless this equivalence is not absolute, as there are sometimes produced individual variations which appear to become intensified with the number of the substitutions. Zinc and other metals are capable of being substituted for hydrogen in presence of the radicle NO_2 in a molecule of camphor, and of giving rise to substitution-products different from the foregoing.

No. 7, August 17, 1885.

The Action of Phosphonium Iodide on Ethylen Oxide.—J. de Girard.—By this reaction the author has obtained white acicular crystals of ethylen di-iodide.

The Elective Alcoholic Fermentation of Inverted Sugar.—H. Leplay.—The author, in opposition to M. Bourquelot and M. Maumené, maintains the real existence of elective alcoholic fermentation.

———
Zeitschrift für Analytische Chemie.
Vol. xxiv., Part 3, 1885.

The Reflux of Liquids in Burettes.—H. von Jüptner.—Experiment shows that both water and alcohol reach their ultimate level in three minutes.

Filtration under Pressure.—B. F. Davenport.—From the CHEMICAL NEWS.

Modification of the Bunsen Gas-Lamp.—R. Muencke.—In this paper, which is accompanied by three illustrations, the author proposes that the aperture for the gas should not consist of three slits, but should be circular.

Removal of Pernicious or Unpleasant Vapours.—R. C. Cooley.—From the CHEMICAL NEWS.

The Recovery of Uranium Residues.—M. Savery.—From the CHEMICAL NEWS.

Volumetric Determination of Manganese in Ferro-manganese and Manganese Ores.—E. Hintz.—A number of methods are here given, arranged under four heads:—Determination of manganese by conversion into oxide, and titration; conversion into peroxide by means of a standard solution of permanganate; determination

of manganese by conversion into peroxide, and subsequent titration; and, lastly, determination of manganese by conversion into acid manganese phosphate, and its titration with ammonium ferrous sulphate.

Determination of Nitrogen.—U. Kreusler.—The substance of this voluminous memoir will be inserted in some detail.

Method for Determination of Ortho-toluidine in Presence of Para-toluidine.—G. Lunge.—This method is founded on the sp. gr., and is applicable to all liquid mixtures. A table is appended showing the sp. gravities from 100 down to 40 per cent of ortho-toluidine.

The Influence of the Volume of the Lead Precipitate in Determinations of Sugar.—MM. Bicard and Pellet.—The volume of this precipitate may in general be neglected.

Determination of Microbia in the Air.—W. Hesse. The author uses a glass tube 70 c.m. long and 3.5 c.m. in width. Over one end of the tube he ties a tightly fitting caoutchouc cap with a central round aperture about 1 c.m. in diameter. Over this he fixes a second cap without aperture, so that the tube is completely closed at this end. Into the tube thus prepared are introduced 50 grms. culture-gelatin prepared as follows:—50 grms. gelatin are softened in 500 c.c. water, and then boiled. On the other hand 1 lb. of finely minced meat is let stand with 500 c.c. water in an ice-closet for twenty-four hours. The meat is strongly pressed, the liquid obtained is boiled, filtered through fine gauze, 10 grms. of peptone and 1 gram. of common salt are added, the whole is neutralised with sodium carbonate, and filtered while hot. The yield is 1 litre. It is sterilised by repeated boiling and thus preserved from putrefaction. The open end of the tube is closed with a caoutchouc stopper, through which passes a glass tube, 10 c.m. in length and 1 c.m. in width, fitted with two plugs of wadding. The tube thus arranged is freed from all germs capable of development in Koch's steam sterilising apparatus. When taken out of this apparatus, as long as the gelatin is still liquid the tube is constantly moved up and down, and at the same time turned rapidly on its axis, so that the gelatin when cold may line the inside of the tube evenly. Finally, in order to kill any microbia which may have attached themselves to its surface, the tube is plunged for one to two minutes into a 1 per cent solution of mercuric chloride. It is then fixed horizontally upon a suitable support, the smaller tube is connected with an aspirator, the outer caoutchouc cap is removed, the hands having first been washed in corrosive sublimate, and the aspirator is set in action. By its means the air drawn through is measured, and the current is regulated so that in the open air 1 litre of air passes through in two to three minutes, and in dwelling rooms in three to four minutes. In successful experiments the germs will have been deposited so far apart that the colonies proceeding from them will have been able to develop without leaving too large intervening spaces unoccupied. In 20 litres of air taken in the open air in Berlin in dry weather, the author found from 4 to 20 germs capable of development. In dwelling rooms the germs, especially of bacteria, are more numerous, especially if the air is in motion. In 10 litres of air taken in a school-room before the entrance of the pupils there were 20 germs; during occupation 165, and after the exit of the scholars, 350.

Directions for Judging the Results of the Chemico-microscopic Examination of Water.—No particulars.

Detection of Wheat-Flour in Rye-Flour.—L. Wittmack.—The starch-granules of rye-flour are almost all swollen at 62.5°, and most of them burst, while wheat-starch granules retain their texture.

Conclusions from the Results of the Analysis of Chocolate.—R. Bensemann.—The author founds his conclusions on the relative proportion of fat, starch, and matter insoluble in water.

Spectroscopic Examination of Vinegar for Free Mineral Acids, and of Flour and Bread for Ergot.—J. Uffelmann.—No particulars are given.

Maple Sugar.—H. W. Wiley.—From the *CHEMICAL NEWS*.

Incineration of Raw Sugars.—Lippmann.—The author dries the sample in a platinum or porcelain capsule and then saturates it with vaseline oil. The incineration is then easily effected.

The Use of the Volumenometer in the Examination of Foods, &c.—W. Thörner.—No particulars are given.

A New Apparatus for Determining the Flashing-Point of Petroleum.—R. Heumann.—This apparatus is merely mentioned.

An Approximate Determination of the Rosin in Soft Soaps.—G. Heiner.—The author determines total acids in a portion of the sample. The solution of a second portion is salted out in a separating-funnel. The waste lyes are run off and the soap washed again with a solution of salt. Resin-soap, glycerin, and impurities run off in the waste lye, and are removed. The washed soap is decomposed with sulphuric acid, the fatty acids are determined, and their amount deduced from that of the total acids as obtained above. The quantity of the resin appears as the difference.

The Lubricating Value of Oils.—W. H. Lepenau.—This paper cannot be intelligibly reproduced without the illustration.

Test for Cod-Liver Oil.—J. L. Rössler.—Genuine cod-liver oil gives with aqua-regia a dark greenish-yellow liniment, which becomes brown in half an hour. White seal-oil and even a mixture of equal parts of the two oils gives merely a pale yellow liniment.

Analysis of Vegetable Matters.—E. Reichardt.—A combination of known methods, which is therefore not described.

Examination of Ethereal Oils.—W. H. Langbeck.—Salicylic acid is more readily soluble in oxygenous, less readily in non-oxygenous oils. The oils of the Libiatae dissolve most of it, then those of the Umbelliferae and those of the Coniferae least.

Ergot.—Kaster.—Recent ergot, if powdered and let stand in ether with frequent agitation, gives an almost colourless extract. Old samples yield a distinctly yellow extract.

Menthol Pencils.—These are now often adulterated with thymol. Eykman dissolves a little of the sample in 1 c.c. glacial acetic acid, adds 5 to 6 drops strong sulphuric acid and 1 drop nitric acid. If thymol is present a blue colouration is produced. Salicylic acid, menthol, camphol, and borneol give, under these circumstances, no colour.

Detection and Determination of Gum-Ammoniac.—P. C. Plugge.—No particulars are given.

Antipyrine.—Otto Schweissinger.—The author gives a tabular list of its reactions.

The following papers are merely mentioned:—

Thallin.—G. Vulpius.

Determination of Morphine in Opium.—Von Perger.

Criticism on the Test-Methods of the "Pharmacopœia Germanica."—K. Thümmel.

Determination of Chlorides in Animal Liquids.—C. Arnold.—The author considers his process applicable not merely to the urine of various animals, but to blood serum, milk, and various pathological albumenoid liquids. For urine he mixes 10 c.c. of the sample in a 100 c.c. measuring flask with 20 to 30 drops of nitric acid and adds 2 c.c. of the solution of iron-ammonium alum and 10 to 15 drops of an eight to ten per cent solution of permanganate. When the dark colour has disappeared decinormal silver solution is added until a drop flowing

down the side of the vessel no longer produces any turbidity. He then fills up to 100 c.c. and concludes the process in the manner formerly described. In stale samples the absence of nitrites must be ascertained.

Determination of Chlorine in Urine.—W. Zuelzer.—A known volume of the sample, 10 to 15 c.c., is acidulated with nitric acid and precipitated with silver nitrate. The silver chloride obtained is filtered off, placed in a measuring flask holding 300 c.c., and precipitated, first with a colourless solution of ammonium or potassium sulphide, to remove the silver, and then with cadmium nitrate to remove excess of sulphur. He then makes up to 300 c.c., agitates well, filters, and determines the chlorine by Mohr's process in an aliquot portion.

Determination of Sulphur in Protein-Substances.—O. Hammarsten.—A criticism of existing processes. The author gives the preference to Liebig's old process.

Titration of Urea by Liebig's Process.—Th. Pfeiffer.—The author, in opposition to Pflüger, maintains that Rautenberg's modification of Liebig's process gives accurate results under all circumstances if calcium carbonate is used as the neutralising agent.

A Simplified Apparatus for Determining Urea with Bromine Water.—A. W. Gerrard.—A modification of Knop's apparatus, giving the result in direct percentages.

Determination of Oxalic Acid in Urine.—A critique on the methods of Schultzen, Neubauer, and Wesley Mills.

New Reactions for Glucose and Lactose.—M. Rübner.—If a dilute solution of glucose is mixed with a solution of lead acetate, and if ammonia is added drop by drop until a permanent precipitate appears, this precipitate on standing turns first yellowish and then rose-colour or flesh-colour. Cane-sugar and dextrine, if similarly treated, give no colouration. If milk-sugar is boiled with lead acetate for a few minutes, it turns yellow or brownish. If ammonia is then added as long as the precipitate re-dissolves there is at first a yellow colouration passing to a brick-red, and then the deposit of a cherry-red or copper-coloured precipitate. An excess of lead acetate is necessary.

Phenyl-hydrazine as Reagent for Sugar in Urine.—Jaksch and Grocco.—50 c.c. of the sample are mixed with a solution of 2 grms. phenyl-hydrazine hydrochlorate and 1½ grms. sodium acetate in 20 c.c. water, and heated in the water-bath. If sugar is present phenyl-glucosazon is deposited in about ten to fifteen minutes in stellar groups of yellowish needles.

Optical Determination of Lactose in Milk.—H. W. Wiley.—The author precipitates the albumenoids with a solution of mercuric nitrate in nitric acid or mercuric iodide in acetic acid and polarises the filtrate.

A New Reaction for Albumen.—D. Axenfeld.—If a solution of albumen is acidified with formic acid, a solution of gold chloride at 0.1 per cent added drop by drop, and heat applied, the solution first becomes rose, then a splendid purple, on continued addition blue, and finally a flocculent precipitate is deposited. The red colour only is characteristic.

Determination of Casein in Cow's Milk.—J. Frenzel and Th. Weyl.—30 c.c. of the milk are poured through a pipette into 60 c.c. cold water, and mixed with 30 c.c. sulphuric acid at 0.1 per cent, stirring continually. The precipitate, after standing for some hours in the cold, is filtered, washed with water, alcohol, and ether, dried, and weighed.

Behaviour of Serum-Albumen with Acids and Neutral Salts.—E. Johannsen.—This body has a remarkable power of resisting the action of acids.

Influence of the Reaction upon the Separate Determination of Albumen and Globuline in Urine.—A. Ott.—The danger of precipitating albumen along with

globuline is avoided if the acid reaction is reduced to close upon the amphoteric point.

New Reaction of Carbon Monoxide—Hæmoglobin.—Stanislaus Zaleski.—A saturated solution of copper sulphate, chloride, acetate, or nitrate is diluted with 3 volumes of water and a few drops are added to 4 c.c. of the blood previously diluted to double its volume. It is then shaken up, and in a few minutes afterwards, if carbon monoxide is present, a brick-red precipitate is deposited. Normal blood yields a dark chocolate-brown deposit.

Detection of Arsenic in Criminal Cases.—H. Beckurts.—Already inserted.

On Ptomaines.—L. Brieger.—The author comminutes the organs, stirs up with water, acidulates slightly with hydrochloric acid, heats nearly to boiling, and filters while hot. The filtrate is evaporated on the water-bath to a syrup keeping it just perceptibly acid, and taken up in alcohol. The alcoholic solution gave a precipitate with platinum chloride consisting principally of the potassium double salt. On treatment with water the platinum double compound of choline was dissolved out. The solution was treated with sulphuretted hydrogen, the solution evaporated down, neutralising the excess of acid with soda, and the residue was taken up with absolute alcohol. The evaporated residue of the alcoholic extract was dissolved in water, and on the addition of gold chloride deposited the sparingly soluble double gold compound in crystals. On prolonged putrefaction there was obtained a compound closely resembling muscaine in its physiological action.

Separation of Alkaloids from Human Remains.—H. Beckurts.—The author extracts with an alcoholic solution of oxalic acid and treats the united extracts as usual.

Detection of Strychnine.—Th. Chandelon.—The author mixes the comminuted internal organs with an equal weight of dehydrated gypsum, breaks up the cold mass into small fragments, dries at 70°, pulverises and extracts at a boil with alcohol at 90 per cent, to which a little tartaric acid (1 per cent on the weight of the recent organic matter) has been added. This operation is performed in a cohobator. The liquid is filtered and the residue repeatedly washed with hot alcohol. The acid filtrate is evaporated to dryness on the water-bath, the residue taken up with a little boiling water, allowed to cool to separate fat, and filtered. The filtrate concentrated to 20 to 25 c.c. is made distinctly alkaline with soda-lye, mixed with gypsum on a watch-glass, the solidified mass is pulverised, the powder dried in the exsiccator, and then extracted with chloroform in a Soxhlet's apparatus. The chloroformic solution is mixed with an equal volume of a saturated solution of oxalic acid in ether. In presence of strychnine its oxalate is soon deposited in needles arranged in little brushes. These may be collected, washed with a mixture of equal parts of ether and chloroform, dried, and finally dissolved in a minimum of water, from which solution, on the addition of water, strychnine is gradually deposited in needles. Morphine, narcotine, and colchicine cannot be detected by this process. But brucine, narceine, aconitine, atropine, hyoscyamine, veratrine, nicotine, and coniine are completely precipitated from the chloroform by an ethereal solution of oxalic acid. Traces of papaverine and thebaine remain in solution.

Journal für Praktische Chemie.

New Series, Vol. xxxi., Parts 10 and 11.

Electro-chemical Studies (Second Memoir: Law of Dilution).—W. Ostwald.—The progress which the molecular conductivity of acids displays on increasing dilution is so characteristic that it can be applied for the recognition of the unitary nature, especially in monobasic acids.

In the course of his researches on the influence of chemical constitution upon electric conductivity, the author has several times been made aware of impurities in the bodies submitted to experiment by deviations from the normal course.

The Action of Sodium Mercaptide upon Phenyl-ester.—R. Seifert.—“Alcohol, mercaptan, phenol, thio-phenol” form a series in which the basic properties decrease from left to right, whilst the acid properties increase. Thus at common temperatures the phenolates have no action upon the esters of the alcohols, for the acid phenol is already combined with a base, and the more basic alcohol is already combined with an acid. The only possible conversion in this case—*i. e.*, that the acid of the ester seizes upon the alkali with simultaneous formation of phenyl ether—occurs only with the esters of the mineral acids, and then only at elevated temperatures. On the other hand, phenolates convert the esters of thio-phenol, even at common temperatures, into thio-phenolate and esters of phenol.

The Influence of Temperature upon the Capillary Marginal Angle.—J. Traube.—The author finds that there is for every liquid one only temperature, depending upon the nature of the liquid and of the containing tube in which the meniscus is hemispheric, and above which the marginal angle is finite and increases continuously.

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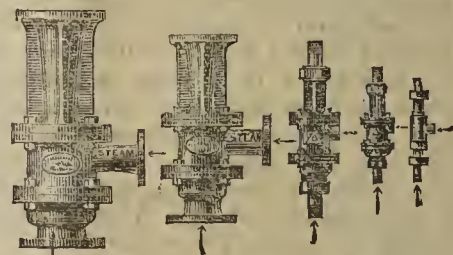
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BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ABERDEEN MEETING, SEPTEMBER 9, 1885.

INAUGURAL ADDRESS OF THE PRESIDENT,
THE RIGHT HON. SIR LYON PLAYFAIR K.C.B., M.P.,
F.R.S.

I. Visit to Canada.

LADIES AND GENTLEMEN,—Our last meeting at Montreal was a notable event in the life of the British Association, and even marked a distinct epoch in the history of civilisation. It was by no mere accident that the constitution of the Association enabled it to embrace all parts of the British Empire. Science is truly catholic, and is bounded only by the universe. In relation to our vast empire, science as well as literature and art are the common possession of all its varying people. The United Kingdom is limited to 120,800 square miles, inhabited by 35 millions of people; but the empire as a whole has 8½ millions of square miles, with a population of 305 millions. To federate such vast possessions and so teeming a population into a political unit is a work only to be accomplished by the labours and persistent efforts of perhaps several generations of statesmen. The federation of its science is a subject of less dimensions well within the range of experiment. No part of the British Empire was more suited than Canada to try whether her science could be federated with our science. Canada has lately federated distinct provinces, with conflicting interests arising from difference of races, nationalities, and religions. Political federation is not new in the history of the world, though it generally arises as a consequence of war. It was war that taught the Netherlands to federate in 1619. It was war which united the States in America; federated Switzerland, Germany, and Austria, and unified Italy. But Canada formed a great national life out of petty provincial existences in a time of profound peace. This evolution gave an immense impulse to her national resources. The Dominion still requires consolidation in its vast extent, and applied science is rapidly effecting it. Canada, with its great expanse of territory, nearly as large as the United States, is being knit together by the iron bands of railways from the Gulf of St Lawrence to the Pacific Ocean, so that the fertile lands of Ontario, Manitoba, Columbia, and the North-Western territories will soon be available to the world. Still practical science has much to accomplish. England and France, with only one-fifth the fertile area of Canada, support 80 millions of people, while Canada has a population not exceeding 5 millions.

A less far-seeing people than the Canadians might have invited the applied science which they so much require. But they knew that without science there are no applications. They no doubt felt with Emerson—

And what if Trade sow cities
Like shells along the shore,
And thatch with towns the prairie broad
With railways ironed o'er;
They are but sailing foam-bells
Along Thought's causing stream,
And take their shape and sun-colour
From him that sends the dream.

So it was with a far-reaching foresight that the Canadian Government invited the British Association for the Ad-

vancement of Science to meet in Montreal. The inhabitants of Canada received us with open arms, and the science of the Dominion and that of the United Kingdom were welded. We found in Canada, as we had every reason to expect, men of manly and self-reliant character who loved not less than we did the old home from which they had come. Among them is the same healthiness of political and moral life, with the same love of truth which distinguishes the English people. Our great men are their great men; our Shakspeare, Milton, and Burns belong to them as much as to ourselves; our Newton, Dalton, Faraday, and Darwin are their men of science as much as they are ours. Thus a common possession and mutual sympathy made the meeting in Canada a successful effort to stimulate the progress of science, while it established, at the same time, the principle that all people of British origin—and I would fain include our cousins in the United States—possess a common interest in the intellectual glories of their race, and ought, in science at least, to constitute part and parcel of a common empire, whose heart may beat in the small islands of the Northern seas, but whose blood circulates in all her limbs, carrying warmth to them and bringing back vigour to us. Nothing can be more cheering to our Association than to know that many of the young communities of English-speaking people all over the globe—in India, China, Japan, the Straits, Ceylon, Australia, New Zealand, the Cape—have founded scientific societies in order to promote the growth of scientific research. No doubt science, which is only a form of truth, is one in all lands, but still its unity of purpose and fulfilment received an important practical expression by our visit to Canada. This community of science will be continued by the fact that we have invited Sir William Dawson, of Montreal, to be our next President at Birmingham.

II. Science and the State.

I cannot address you in Aberdeen without recollecting that when we last met in this city our President was a great prince. The just verdict of time is that, high as was his royal rank, he has a far nobler claim to our regard as a lover of humanity in its widest sense, and especially as a lover of those arts and sciences which do so much to adorn it. On September 14, 1859, I sat on this platform and listened to the eloquent address and wise counsel of the Prince Consort. At one time a member of his household it was my privilege to co-operate with this illustrious prince in many questions relating to the advancement of science. I naturally, therefore, turn to his presidential address to see whether I might not now continue those counsels which he then gave with all the breadth and comprehensiveness of his masterly speeches. I found, as I expected, a text for my own discourse in some pregnant remarks which he made upon the relation of Science to the State. They are as follows:—"We may be justified in hoping . . . that the Legislature and the State will more and more recognise the claims of science to their attention, so that it may no longer require the begging-box, but speak to the state like a favoured child to its parent, sure of his paternal solicitude for its welfare; that the State will recognise in science one of its elements of strength and prosperity, to foster which the clearest dictates of self-interest demand."

This opinion, in its broadest sense, means that the relations of Science to the State should be made more intimate because the advance of science is needful to the public weal.

The importance of promoting science as a duty of statecraft was well enough known to the ancients, especially to the Greeks and Arabs, but it ceased to be recognised in the Dark Ages, and was lost to sight during the revival of letters in the fifteenth and sixteenth centuries. Germany and France, which are now in such active competition in promoting science, have only publicly acknowledged its national importance in recent times. Even in the last century, though France had its Lavoisier and

Germany its Leibnitz, their Governments did not know the value of science. When the former was condemned to death in the Reign of Terror, a petition was presented to the rulers that his life might be spared for a few weeks in order that he might complete some important experiments, but the reply was "The Republic has no need of savants." Earlier in the century the much-praised Frederick William of Prussia shouted with a loud voice, during a graduation ceremony in the University of Frankfurt, "An ounce of mother-wit is worth a ton of university wisdom." Both France and Germany are now ashamed of these utterances of their rulers, and make energetic efforts to advance science with the aid of their national resources. More remarkable is it to see a young nation like the United States reserving 150,000,000 acres of national lands for the promotion of scientific education. In some respects this young country is in advance of all European nations in joining science to its administrative offices. Its scientific publications, like the great palæontological work embodying the researches of Prof. Marsh and his associates in the Geological Survey, are an example to other Governments. The Minister of Agriculture is surrounded with a staff of botanists and chemists. The Home Secretary is aided by a special Scientific Commission to investigate the habits, migrations, and food of fishes, and the latter has at its disposal two specially-constructed steamers of large tonnage. The United States and Great Britain promote fisheries on distinct systems. In this country we are perpetually issuing expensive Commissions to visit the coasts in order to ascertain the experiences of fishermen. I have acted as Chairman of one of these Royal Commissions, and found that the fishermen, having only a knowledge of a small area, gave the most contradictory and unsatisfactory evidence. In America the questions are put to Nature, and not to fishermen. Exact and searching investigations are made into the life-history of the fishes, into the temperature of the sea in which they live and spawn, into the nature of the food, and into the habits of their natural enemies. For this purpose the Government give the co-operation of the navy, and provide the Commission with a special corps of skilled naturalists, some of whom go out with the steamships, and others work in the biological laboratories at Wood's Holl, Massachusetts, or at Washington. The different universities send their best naturalists to aid in these investigations, which are under the direction of Mr. Baird, of the Smithsonian Institution. The annual cost of the Federal Commission is about £40,000, while the separate States spend about £20,000 in local efforts. The practical results flowing from these scientific investigations have been important. The inland waters and rivers have been stocked with fish of the best and most suitable kinds. Even the great ocean which washes the coasts of the United States is beginning to be affected by the knowledge thus acquired, and a sensible result is already produced upon the most important of its fisheries. The United Kingdom largely depends upon its fisheries, but as yet our Government have scarcely realised the value of such scientific investigations as those pursued with success by the United States. Less systematically, but with great benefit to science, our own Government has used the surveying expeditions, and sometimes has equipped special expeditions to promote natural history and solar physics. Some of the latter, like the voyage of the *Challenger*, have added largely to the store of knowledge; while the former, though not primarily intended for scientific research, have had an indirect result of infinite value by becoming training-schools for such investigators as Edward Forbes, Darwin, Hooker, Huxley, Wyville Thomson, and others.

In the United Kingdom we are just beginning to understand the wisdom of Washington's farewell address to his countrymen, when he said: "Promote as an object of primary importance institutions for the general diffusion of knowledge. In proportion as the structure of a government gives force to public opinion, it is essential

that public opinion should be enlightened." It was only in 1870 that our Parliament established a system of national primary education. Secondary education is chaotic, and remains unconnected with the State, while the higher education of the universities is only brought at distant intervals under the view of the State. All great countries except England have Ministers of Education, but this country has only Ministers who are the managers of primary schools. We are inferior even to smaller countries in the absence of organised State supervision of education. Greece, Portugal, Egypt, and Japan have distinct Ministers of Education, and so also among our Colonies have Victoria and New Zealand. Gradually England is gathering materials for the establishment of an efficient Education Minister. The Department of Science and Art is doing excellent work in diffusing a taste for elementary science among the working classes. There are now about 78,000 persons who annually come under the influence of its science classes, while a small number of about two hundred, many of them teachers, receive thorough instruction in science at the excellent school in South Kensington of which Professor Huxley is the Dean. I do not dwell on the work of this Government department, because my object is chiefly to point out how it is that science lags in its progress in the United Kingdom owing to the deficient interest taken in it by the middle and upper classes. The working classes are being roused from their indifference. They show this by their selection of scientific men as candidates at the next election. Among these are Professors Stuart, Roscoe, Maskelyne, and Rücker. It has its significance that such a humble representative of science as myself received invitations from working-class constituencies in more than a dozen of the leading manufacturing towns. In the next Parliament I do not doubt that a Minister of Education will be created as a nucleus round which the various educational materials may crystallise in a definite form.

III. Science and Secondary Education.

Various Royal Commissions have made inquiries and issued recommendations in regard to our Public and endowed schools. The Commissions of 1861, 1864, 1868, and 1873 have expressed the strongest disapproval of the condition of our schools, and, so far as science is concerned, their state is much the same as when the Duke of Devonshire's Commission in 1873 reported in the following words:—"Considering the increasing importance of science to the material interests of the country, we cannot but regard its almost total exclusion from the training of the upper and middle classes as little less than a national misfortune." No doubt there are exceptional cases and some brilliant examples of improvement since these words were written, but generally throughout the country teaching in science is a name rather than a reality. The Technical Commission which reported last year can only point to three schools in Great Britain in which science is fully and adequately taught. While the Commission gives us the consolation that England is still in advance as an industrial nation, it warns us that foreign nations, which were not long ago far behind, are now making more rapid progress than this country, and will soon pass it in the race of competition unless we give increased attention to science in public education. A few of the large towns, notably Manchester, Bradford, Huddersfield, and Birmingham, are doing so. The working classes are now receiving better instruction in science than the middle classes. The competition of actual life asserts its own conditions, for the children of the latter find increasing difficulty in obtaining employment. The cause of this lies in the fact that the schools for the middle classes have not yet adapted themselves to the needs of modern life. It is true that many of the endowed schools have been put under new schemes, but as there is no public supervision or inspection of them, we have no knowledge as to whether they have prospered or slipped back. Many corporate schools have arisen, some of them,

like Clifton, Cheltenham, and Marlborough Colleges, doing excellent educational work, though as regards all of them the public have no rights and cannot enforce guarantees for efficiency. A Return just issued, on the motion of Sir John Lubbock, shows a lamentable deficiency in science teaching in a great proportion of the endowed schools. While twelve to sixteen hours per week are devoted to classics, two to three hours are considered ample for science in a large proportion of the schools. In Scotland there are only six schools in the Return which give more than two hours to science weekly, while in many schools its teaching is wholly omitted. Every other part of the kingdom stands in a better position than Scotland in relation to the science of its endowed schools. The old traditions of education stick as firmly to schools as a limpet does to a rock; though I do the limpet injustice, for it does make excursions to seek pastures new. Are we to give up in despair because an exclusive system of classical education has resisted the assaults of such cultivated authors as Milton, Montaigne, Cowley, and Locke? There was once an enlightened Emperor of China, Chi Hwangti, who knew that his country was kept back by its exclusive devotion to the classics of Confucius and Mencius. He invited 500 of the teachers to bring their copies of these authors to Peking, and after giving a great banquet in their honour, he buried alive the professors along with their manuscripts in a deep pit. But Confucius and Mencius still reign supreme. I advocate milder measures, and depend for their adoption on the force of public opinion. The needs of modern life will force schools to adapt themselves to a scientific age. Grammar-schools believe themselves to be immortal. Those curious immortals—the Struldbrugs—described by Swift, ultimately regretted their immortality, because they found themselves out of touch, sympathy, and fitness with the centuries in which they lived.

As there is no use clamouring for an instrument of more compass and power until we have made up our mind as to the tune, Professor Huxley, in his evidence before a Parliamentary Committee in 1884, has given a time-table for grammar-schools. He demands that out of their forty hours for public and private study ten should be given to modern languages and history, eight to arithmetic and mathematics, six to science, and two to geography, thus leaving fourteen hours to the dead languages. No time-table would, however, be suitable to all schools. The great public schools of England will continue to be the gymnasia for the upper classes, and should devote much of their time to classical and literary culture. Even now they introduce into their curriculum subjects unknown to them when the Royal Commission of 1868 reported, though they still accept science with timidity. Unfortunately, the other grammar-schools which educate the middle classes look to the higher public schools as a type to which they should conform, although their functions are so different. It is in the interest of the higher public schools that this difference should be recognised, so that, while they give an all-round education and expand their curriculum by a freer recognition of the value of science as an educational power in developing the faculties of the upper classes, the schools for the middle classes should adapt themselves to the needs of their existence, and not keep up a slavish imitation of schools with a different function. The old classical grammar-schools may view these remarks as a direct attack upon them, and so it is in one sense, but it is like the stroke of Ithuriel's spear, which heals while it wounds.

The stock argument against the introduction of modern subjects into grammar-schools is that it is better to teach Latin and Greek thoroughly rather than various subjects less completely. But is it true that thoroughness in teaching dead languages is the result of an exclusive system? In 1868 the Royal Commission stated that even in the few great public schools thoroughness was only given to thirty per cent of the scholars, at the sacrifice of seventy per cent who got little benefit from the system.

Since then the curriculum has been widened and the teaching has improved. I question the soundness of the principle that it is better to limit the attention of the pupils mainly to Latin and Greek, highly as I value their educational power to a certain order of minds. As in biology the bodily development of animals is from the general to the special, so is it in the mental development of man. In the school a boy should be aided to discover the class of knowledge that is best suited for his mental capacities, so that, in the upper forms of the school and in the university, knowledge may be specialised in order to cultivate the powers of the man to their fullest extent. Shakspeare's educational formula may not be altogether true, but it contains a broad basis of truth—

No profit goes, where is no pleasure ta'en;—
In brief, sir, study what you most affect.

The comparative failure of the modern side of school education arises from constituting it out of the boys who are looked upon as classical asses. Milton pointed out that in all schools there are boys to whom the dead languages are "like thorns and thistles," which form a poor nourishment even for asses. If teachers looked upon these classical asses as beings who might receive mental nurture according to their nature, much higher results would follow the bifurcation of our schools. Saul went out to look for asses and he found a kingdom. Surely this fact is more encouraging than the example of Gideon, who "took thorns of the wilderness and briars, and with these he taught the men of Succoth."* The adaptation of public schools to a scientific age does not involve a contest as to whether science or classics shall prevail, for both are indispensable to true education. The real question is whether schools will undertake the duty of moulding the minds of boys according to their mental varieties. Classics, from their structural perfection and power of awakening dormant faculties, have claims to precedence in education, but they have none to a practical monopoly. It is by claiming the latter that teachers sacrifice mental receptivity to a Procrustean uniformity.

The universities are changing their traditions more rapidly than the schools. The *via antiqua* which leads to them is still broad, though a *via moderna*, with branching avenues, is also open to their honours and emoluments. Physical science, which was once neglected, is now encouraged at the universities. As to the seventy per cent of boys who leave schools for life-work without going through the universities, are there no growing signs of discontent which must force a change? The Civil Service, the learned professions, as well as the army and navy, are now barred by examinations. Do the boys of our public schools easily leap over the bars, although some of them have lately been lowered so as to suit the schools? So difficult are these bars to scholars that crammers take them in hand before they attempt the leap; and this occurs in spite of the large value attached to the dead languages and the small value placed on modern subjects. Thus, in the Indian Civil Service examinations, 800 marks as a maximum are assigned to Latin, 600 to Greek, 500 to chemistry, and 300 to each of the other physical sciences. But if we take the average working of the system for the last four years, we find that while sixty-eight per cent of the maximum were given to candidates in Greek and Latin, only forty-five per cent were accorded to candidates in chemistry, and but thirty per cent to the other physical sciences. Schools sending up boys for competition naturally shun subjects which are dealt with so hardly and so heavily handicapped by the State.

Passing from learned or public professions to commerce, how is it that in our great commercial centres, foreigners—German, Swiss, Dutch, and even Greeks—push aside our English youth and take the places of profit which belong to them by national inheritance? How is it that in our Colonies, like those in South Africa, German enterprise is pushing aside English incapacity? How is it that

* "Judges," viii., 16.

we find whole branches of manufactures, when they depend on scientific knowledge, passing away from this country, in which they originated, in order to engraft themselves abroad, although their decaying roots remain at home? The answer to these questions is that our systems of education are still too narrow for the increasing struggle of life.

Faraday, who had no narrow views in regard to education, deplored the future of our youth in the competition of the world, because, as he said with sadness, "our schoolboys, when they come out of school, are ignorant of their ignorance at the end of all that education."

The opponents of science education allege that it is not adapted for mental development, because scientific facts are often disjointed and exercise only the memory. Those who argue thus do not know what science is. No doubt an ignorant or half-informed teacher may present science as an accumulation of unconnected facts. At all times and in all subjects there are teachers without æsthetical or philosophical capacity—men who can only see carbonate of lime in a statue by Phidias or Praxiteles; who cannot survey zoology on account of its millions of species, or botany because of its 130,000 distinct plants; men who can look at trees without getting a conception of a forest, and cannot distinguish a stately edifice from its bricks. To teach in that fashion is like going to the tree of science with its glorious fruit in order to pick up a handful of the dry fallen leaves from the ground. It is, however, true that as science teaching has had less lengthened experience than that of literature, its methods of instruction are not so matured. Scientific and literary teaching have different methods; for while the teacher of literature rests on authority and on books for his guidance, the teacher of science discards authority and depends on facts at first hand, and on the book of Nature for their interpretation. Natural science more and more resolves itself into the teaching of the laboratory. In this way it can be used as a powerful means of quickening observation, and of creating a faculty of induction after the manner of *Zadig*, the Babylonian described by Voltaire. Thus facts become surrounded by scientific conceptions, and are subordinated to order and law.

It is not those who desire to unite literature with science who degrade education; the degradation is the consequence of the refusal. A violent reaction—too violent to be wise—has lately taken place against classical education in France, where their own vernacular occupies the position of dead languages, while Latin and science are given the same time in the curriculum. In England manufacturers cry out for technical education, in which classical culture shall be excluded. In the schools of the middle classes science rather than technics is needed, because, when the seeds of science are sown, technics as its fruit will appear at the appointed time. Epictetus was wise when he told us to observe that though sheep eat grass, it is not grass but wool that grows on their backs. Should, however, our grammar-schools persist in their refusal to adapt themselves to the needs of a scientific age, England must follow the example of other European nations and found new modern schools in competition with them. For, as Huxley has put it, we cannot continue in this age "of full modern artillery to turn out our boys to do battle in it, equipped only with the sword and shield of an ancient gladiator." In a scientific and keenly competitive age an exclusive education in the dead languages is a perplexing anomaly. The flowers of literature should be cultivated and gathered, though it is not wise to send men into our fields of industry to gather the harvest when they have been taught only to cull the poppies and to push aside the wheat.

IV. Science and the Universities.

The State has always felt bound to alter and improve universities, even when their endowments are so large as

to render it unnecessary to support them by public funds. When universities are poor, Parliament gives aid to them from imperial taxation. In this country that aid has been given with a very sparing hand. Thus the universities and colleges of Ireland have received about thirty thousand pounds annually, and the same sum has been granted to the four universities of Scotland. Compared with imperial aid to foreign universities such sums are small. A single German university like Strasburg or Leipsic receives above £40,000 annually, or £10,000 more than the whole colleges of Ireland or of Scotland. Strasburg, for instance, has had her university and its library rebuilt at a cost of £711,000, and receives an annual subscription of £43,000. In rebuilding the university of Strasburg eight laboratories have been provided, so as to equip it fully with the modern requirements for teaching and research.* Prussia, the most economical nation in the world, spends £391,000 yearly out of taxation on her universities.

The recent action of France is still more remarkable. After the Franco-German War the Institute of France discussed the important question:—"Pourquoi la France n'a pas trouvé d'hommes supérieurs au moment du péril?" The general answer was because France had allowed university education to sink to a low ebb. Before the great Revolution France had twenty-three autonomous universities in the provinces. Napoleon desired to found one great university at Paris, and he crushed out the others with the hand of a despot, and remodelled the last with the instincts of a drill-sergeant. The central university sank so low that in 1868 it is said that only £8,000 were spent for true academic purposes. Startled by the intellectual sterility shown in the war, France has made gigantic efforts to retrieve her position, and has rebuilt the provincial colleges at a cost of £3,280,000, while her annual budget for their support now reaches half a million of pounds. In order to open these provincial colleges to the best talent of France, more than five hundred scholarships have been founded of an annual cost of £30,000. France now recognises that it is not by the number of men under arms that she can compete with her great neighbour Germany, so she has determined to equal her in intellect. You will understand why it is that Germany was obliged, even if she had not been willing, to spend such large sums in order to equip the university of her conquered province, Alsace-Lorraine. France and Germany are fully aware that science is the source of wealth and power, and that the only way of advancing it is to encourage universities to make researches and to spread existing knowledge through the community. Other European nations are advancing on the same lines. Switzerland is a remarkable illustration of how a country can compensate itself for its natural disadvantages by a scientific education of its people. Switzerland contains neither coal nor the ordinary raw materials of industry, and is separated from other countries which might supply them by mountain barriers. Yet, by a singularly good system of graded schools, and by the great technical college of Zurich, she has become a prosperous manufacturing country. In Great Britain we have nothing comparable to this technical college, either in magnitude or efficiency. Belgium is reorganising its universities, and the State has freed the localities from the charge of buildings, and will in future equip the universities with efficient teaching resources out of public taxation. Holland with a population of 4,000,000, and a small revenue of £9,000,000, spends £136,000 on her four universities. Contrast this liberality of foreign countries in the promotion of higher instruction with the action of our own country. Scotland, like Holland, has four universities, and is not very different from it in population, but it only

* See Dr. Perkin's Address to the Soc. Chem. Industry.—*Nature*, Aug. 6, 1885, p. 333.

* The cost of these laboratories has been as follows;—Chemical Institute, £35,000; Physical Institute, £28,000; Botanical Institute, £26,000; Observatory, £25,000; Anatomy, £42,000; Clinical Surgery, £26,000; Physiological Chemistry, £16,000; Physiological Institute, £13,900.

receives £30,000 from the State. By a special clause in the Scotch Universities Bill the Government asked Parliament to declare that under no circumstances should the Parliamentary grant be ever increased above £40,000. According to the views of the British Treasury there is a finality in science and in expanding knowledge.

The wealthy universities of Oxford and Cambridge are gradually constructing laboratories for science. The merchant princes of Manchester have equipped their new Victoria University with similar laboratories. Edinburgh and Glasgow Universities have also done so, partly at the cost of Government and largely by private subscriptions. The poorer universities of Aberdeen and St. Andrews are still inefficiently provided with the modern appliances for teaching science.

London has one small Government college and two chartered colleges, but is wholly destitute of a teaching university. It would excite great astonishment at the Treasury if we were to make the modest request that the great metropolis, with a population of four millions, should be put into as efficient academical position as the town of Strasburg, with 104,000 inhabitants, by receiving, as that town does, £43,000 annually for academic instruction and £700,000 for university buildings. Still, the amazing anomaly that London has no teaching university must ere long cease.

It is a comforting fact that, in spite of the indifference of Parliament, the large towns of the kingdom are showing their sense of the need of higher education. Manchester has already its university. Nottingham, Birmingham, Leeds, and Bristol have colleges more or less complete. Liverpool converts a disused lunatic asylum into a college for sane people. Cardiff rents an infirmary for a collegiate building. Dundee, by private benefaction rears a Baxter College with larger ambitions. All these are healthy signs that the public are determined to have advanced science teaching, but the resources of the institutions are altogether inadequate to the end in view. Even in the few cases where the laboratories are efficient for teaching purposes, they are inefficient as laboratories for research. Under these circumstances the Royal Commission on Science advocates special Government laboratories for research. Such laboratories, supported by public money, are as legitimate subjects for expenditure as galleries for pictures or sculpture; but I think that they would not be successful, and would injure science if they failed. It would be safer in the meantime if the State assisted universities or well-established colleges to found laboratories of research under their own care. Even such a proposal shocks our Chancellor of the Exchequer, who tells us that this country is burdened with public debt, and has ironclads to build and arsenals to provide. Nevertheless our wealth is proportionally much greater than that of foreign States which are competing with so much vigour in the promotion of higher education. They deem such expenditure to be true economy, and do not allow their huge standing armies to be an apology for keeping their people backwards in the march of knowledge. France, which in the last ten years has been spending a million annually on university education, had a war indemnity to pay, and competes successfully with this country in ironclads. Either all foreign States are strangely deceived in their belief that the competition of the world has become a competition of intellect, or we are marvellously unobservant of the change which is passing over Europe in the higher education of the people. Preparations for war will not ensure to us the blessings and security of an enlightened peace. Protective expenditure may be wise, though productive expenditure is wiser.

Were half the powers which fill the world with terror,
Were half the wealth bestowed on camps and courts,
Given to redeem the human mind from error—
There were no need of arsenals and forts.

Universities are not mere storehouses of knowledge; they are also conservatories for its cultivation. In Mexico there is a species of ant which sets apart some of its in-

dividuals to act as honey-jars by monstrously extending their abdomens to store the precious fluid till it is wanted by the community. Professors in a university have a higher function, because they ought to make new honey as well as to store it. The widening of the bounds of knowledge, literary or scientific, is the crowning glory of university life. Germany unites the functions of teaching and research in the universities, while France keeps them in separate institutions. The former system is best adapted to our habits, but its condition for success is that our science chairs should be greatly increased, so that teachers should not be wholly absorbed in the duties of instruction. Germany subdivides the sciences into various chairs, and gives to the professors special laboratories. It also makes it a condition for the higher honours of a university that the candidates shall give proofs of their ability to make original researches. Under such a system, teaching and investigation are not incompatible. In the evidence before the Science Commission many opinions were given that scientific men engaged in research should not be burdened with the duties of education, and there is much to be said in support of this view when a single professor for the whole range of physical science is its only representative in a university. But I hope that such a system will not long continue, for if it do we must occupy a very inferior position as a nation in the intellectual competition of Europe. Research and education in limited branches of higher knowledge are not incompatible. It is true that Galileo complained of the burden imposed upon him by his numerous astronomical pupils, though few other philosophers have echoed this complaint. Newton, who produced order in worlds, and Dalton, who brought atoms under the reign of order and number, rejoiced in their pupils. Lalande spread astronomy as Liebig spread chemistry, and Johannes Müller biology, all over the world. Laplace, La Grange, Dulong, Gay Lussac, Berthollet, and Dumas were professors as well as discoverers in France. In England our discoverers have generally been teachers. In fact I recollect only three notable examples of men who were not—Boyle, Cavendish, and Joule. It was so in ancient as well as in modern times, for Plato and Aristotle taught and philosophised. If you do not make the investigator a schoolmaster, as Dalton was, and as practically our professors are at the present time, with the duty of teaching all branches of their sciences, the mere elementary truths as well as the highest generalisations being compressed into a course, it is well that they should be brought into contact with the world in which they live, so as to know its wants and aspirations. They could then quicken the pregnant minds around them, and extend to others their own power and love of research. Goethe had a fine perception of this when he wrote—

Wer in der Weltgeschichte lebt,
Wer in die Zeiten schaut, und strebt,
Nur der ist weith, zu sprechen und zu dichten.

Our universities are still far from the attainment of a proper combination of their resources between teaching and research. Even Oxford and Cambridge, which have done so much in recent years in the equipment of laboratories and in adding to their scientific staff, are still far behind a second-class German university. The professional faculties of the English Universities are growing, and will diffuse a greater taste for science among their students, though they may absorb the time of the limited professoriate so as to prevent it advancing the boundaries of knowledge. Professional faculties are absolutely essential to the existence of universities in poor countries like Scotland and Ireland. This has been the case from the early days of the Bologna University up to the present time. Originally universities arose not by mere bulls of popes, but as a response to the strong desire of the professional classes to dignify their crafts by real knowledge. If their education had been limited to mere technical schools like the Medical School of Salerno which flourished in the eleventh century, length but not breadth

would have been given to education. So the universities wisely joined culture to the professional sciences. Poor countries like Scotland and Ireland must have their academic systems based on the professional faculties, although wealthy universities like Oxford and Cambridge may continue to have them as mere supplements to a more general education. A greater liberality of support on the part of the State in the establishment of chairs of science, for the sake of science and not merely for the teaching of the professions, would enable the poorer universities to take their part in the advancement of knowledge.

I have already alluded to the foundation of new colleges in different parts of the kingdom. Owens College has worthily developed into the Victoria University. Formerly she depended for degrees on the University of London. No longer will she be like a moon reflecting cold and sickly rays from a distant luminary, for in future she will be a sun, a centre of intelligence, warming and illuminating the regions around her. The other colleges which have formed themselves in large manufacturing districts are remarkable expressions from them that science must be promoted. Including the colleges of a high class, such as University College and King's College in London, and the three Queen's Colleges in Ireland, the aggregate attendance of students in colleges without university rank is between nine and ten thousand, while that of the universities is fifteen thousand. No doubt some of the provincial colleges require considerable improvement in their teaching methods; sometimes they unwisely aim at a full university curriculum when it would be better for them to act as faculties. Still they are all growing in the spirit of self-help, and some of them are destined, like Owen's College, to develop into universities. This is not a subject of alarm to lovers of education, while it is one of hope and encouragement to the great centres of industry. There are too few autonomous universities in England in proportion to its population. While Scotland, with a population of 3½ millions, has four universities with 6500 students, England, with 26 millions of people, has only the same number of teaching universities with 6000 students. Unless English colleges have such ambition, they may be turned into mere mills to grind out material for examinations and competitions. Higher colleges should always hold before their students that knowledge, for its own sake, is the only object worthy of reverence. Beyond college life there is a land of research flowing with milk and honey for those who know how to cultivate it. Colleges should at least show a Pisgah view of this land of promise, which stretches far beyond the Jordan of examinations and competitions.

V. Science and Industry.

In the popular mind the value of science is measured by its applications to the useful purposes of life. It is no doubt true that science wears a beautiful aspect when she confers practical benefits upon man. But truer relations of science to industry are implied in Greek mythology. Vulcan, the god of industry, wooed science, in the form of Minerva, with a passionate love, but the chaste goddess never married, although she conferred upon mankind nearly as many arts as Prometheus, who, like other inventors, saw civilisation progressing by their use while he lay groaning in want on Mount Caucasus. The rapid development of industry in modern days depends on the applications of scientific knowledge, while its slower growth in former times was due to experiments being made by trial and error in order to gratify the needs of man. Then an experiment was less a questioning of Nature than an exercise on the mind of the experimentalist. For a true questioning of nature only arises when intellectual conceptions of the causes of phenomena attach themselves to ascertained facts as well as to their natural environments. Much real science had at one time accumulated in Egypt, Greece, Rome, and Arabia, though it became obscured by the intellectual darkness which spread over Europe like a pall for many centuries.

The mental results of Greek science, filtered through the Romans and Arabians, gradually fertilised the soil of Europe. Even in ages which are deemed to be dark and unprolific, substantial though slow progress was made. By the end of the fifteenth century the mathematics of the Alexandrian school had become the possession of Western Europe; Arabic numerals, algebra, trigonometry, decimal reckoning, and an improved calendar having been added to its stock of knowledge. The old discoveries of Democritus and Archimedes in physics, and of Hipparchus and Ptolemy in astronomy, were producing their natural developments, though with great slowness. Many manufactures, growing chiefly by experience, and occasionally lightened up by glimmerings of science throughout the prevailing darkness, had arisen before the sixteenth century. A knowledge of the properties of bodies, though scarcely of their relations to each other, came through the labours of the alchemists, who had a mighty impulse to work, for by the philosopher's stone, often not larger than half a rape seed, they hoped to attain the three sensuous conditions of human enjoyment, gold, health, and immortality. By the end of the fifteenth century many important manufactures were founded by empirical experiment, with only the uncertain guidance of science. Among these were the compass, printing, paper, gunpowder, guns, watches, forks, knitting-needles, horse-shoes, bells, wood cutting and copper engraving, wire-drawing, steel, table glass, spectacles, microscopes, glass mirrors backed by amalgams of tin and lead, windmills, crushing and saw mills. These important manufactures arose from an increased knowledge of facts, around which scientific conceptions were slowly concreting. Aristotle defines this as science when he says, "Art begins when, from a great number of experiences, one general conception is formed which will embrace all similar cases." Such conceptions are formed only when culture develops the human mind and compels it to give a rational account of the world in which man lives, and of the objects in and around it, as well as of the phenomena which govern their action and evolution. Though the accumulation of facts is indispensable to the growth of science, a thousand facts are of less value to human progress than is a single one when it is scientifically comprehended, for it then becomes generalised in all similar cases. Isolated facts may be viewed as the dust of science. The dust which floats in the atmosphere is to the common observer mere incoherent matter in a wrong place, while to the man of science it is all-important when the rays of heat and light act upon its floating particles. It is by them that clouds and rains are influenced; it is by their selective influence on the solar waves that the blue of the heavens and the beauteous colours of the sky glorify all nature. So, also, ascertained though isolated facts, forming the dust of science, become the reflecting media of the light of knowledge, and cause all Nature to assume a new aspect. It is with the light of knowledge that we are enabled to question Nature through direct experiment. The hypothesis or theory which induces us to put the experimental question may be right or wrong; still, *prudens questio dimidium scientiæ est*—it is half way to knowledge when you know what you have to inquire. Davy described hypothesis as the mere scaffolding of science, useful to build up true knowledge, but capable of being put up or taken down at pleasure. Undoubtedly a theory is only temporary, and the reason is, as Bacon has said, that the man of science "loveth truth more than his theory." The changing theories which the world despises are the leaves of the tree of science drawing nutriment to the parent stems, and enabling it to put forth new branches and to produce fruit; and though the leaves fall and decay, the very products of decay nourish the roots of the tree and reappear in the new leaves or theories which succeed.

When the questioning of Nature by intelligent experiment has raised a system of science, then those men who desire to apply it to industrial inventions proceed by the

same methods to make rapid progress in the arts. They also must have means to compel Nature to reveal her secrets. Æneas succeeded in his great enterprise by plucking a golden branch from the tree of science. Armed with this even dread Charon dared not refuse a passage across the Styx; and the gate of the Elysian fields was unbarred when he hung the branch on its portal. Then new aspects of Nature were revealed—

Another sun and stars they know
That shine like ours, but shine below.

It is by carrying such a golden branch from the tree of science that inventors are able to advance the arts. In illustration of how slowly at first and how rapidly afterwards science and its applications arise, I will take only two out of thousands of examples which lie ready to my hand. One of the most familiar instances is air, for that surely should have been soon understood if man's unaided senses are sufficient for knowledge. Air has been under the notice of mankind ever since the first man drew his first breath. It meets him at every turn; it fans him with gentle breezes, and it buffets him with storms. And yet it is certain that this familiar object—air—is very imperfectly understood up to the present time. We now know by recent researches that air can be liquefied by pressure and cold; but as a child still looks upon air as nothing, so did man in his early state. A vessel filled with air was deemed to be empty. But man, as soon as he began to speculate, felt the importance of air, and deemed it to be a soul of the world upon which the respiration of man and the god-like quality of fire depended. Yet a really intelligent conception of these two essential conditions to man's existence, respiration and combustion, was not formed till about a century ago (1775). No doubt long before that time there had been abundant speculations regarding air. Anaximenes, 548 years before Christ, and Diogenes of Apollonia, a century later, studied the properties of air so far as their senses would allow them; so, in fact, did Aristotle. Actual scientific experiments were made on air about the year 1100 by a remarkable Saracen, Alhazen, who ascertained important truths which enabled Galileo, Torricelli, Otto de Guericke, and others at a later period, to discover laws leading to important practical applications. Still there was no intelligent conception as to the composition of air until Priestley in 1774 repeated, with the light of science, an empirical observation which Eck de Sulbach had made three hundred years before upon the union of mercury with an ingredient of air, and the decomposition of this compound by heat. This experiment now proved that the active element in air is oxygen. From that date our knowledge, derived from an intelligent questioning of air by direct experiments, has gone on by leaps and bounds. The air, which mainly consists of nitrogen and oxygen, is now known to contain carbonic acid, ammonia, nitric acid, ozone, besides hosts of living organisms which have a vast influence for good or evil in the economy of the world. These micro-organisms, the latest contribution to our knowledge of air, perform great analytical functions in organic nature, and are the means of converting much of its potential energy into actual energy. Through their action on dead matter the mutual dependence of plants and animals is secured, so that the air becomes at once the grave of organic death and the cradle of organic life. No doubt the ancients suspected this without being able to prove the dependence. Euripides seems to have seen it deductively when he describes the results of decay:—

Then that which springs from earth, to earth returns,
And that which draws its being from the sky
Rises again up to the skyey height.

The consequences of the progressive discoveries have added largely to our knowledge of life, and have given a marvellous development to the industrial arts. Combustion and respiration govern a wide range of processes. The economical use of fuel, the growth of plants, the food of animals, the processes of husbandry, the maintenance of public health, the origin and cure of disease,

the production of alcoholic drinks, the processes of making vinegar and saltpetre—all these and many other kinds of knowledge have been brought under the dominion of law. No doubt animals respired, fuel burned, plants grew, sugar fermented, before we knew how they depended upon air. But as the knowledge was empirical, it could not be intelligently directed. Now all these processes are ranged in order under a wise economy of Nature, and can be directed to the utilities of life: for it is true, as Swedenborg says, that human "ends always ascend as Nature descends." There is scarcely a large industry in the world which has not received a mighty impulse by the better knowledge of air acquired within a hundred years. If I had time I could show still more strikingly the industrial advantages, which have followed from Cavendish's discovery of the composition of water. I wish that I could have done this, because it was Addison who foolishly said, and Paley who as unwisely approved the remark, "that mankind required to know no more about water than the temperature at which it froze and boiled, and the mode of making steam."

When we examine the order of progress in the arts, even before they are illumined by science, their improvements seem to be the resultants of three conditions.

1. The substitution of natural forces for brute animal power, as when Hercules used the waters of the Alpheus to cleanse the Augean stables; or when a Kamchadal of Eastern Asia, who has been three years hollowing out a canoe, finds that he can do it in a few hours by fire.

2. The economy of time, as when a calendering machine produces the same gloss to miles of calico that an African savage gives to a few inches by rubbing it with the shell of a snail; or the economy of production, as when steel pens, sold when first introduced at one shilling apiece, are now sold at a penny per dozen; or when steel rails, lately costing £45 per ton, can now be sold at £5.

3. Methods of utilising waste products, or of endowing them with properties which render them of increased value to industry, as when waste scrap iron and the galls on the oak are converted into ink; or the badly-smelling waste of gas-works is transformed into fragrant essences, brilliant dyes, and fertilising manure; or when the effete matter of animals or old bones is changed into lucifer-matches.

All three results are often combined when a single end is obtained; at all events, economy of time and production invariably follows when natural forces substitute brute animal force. In industrial progress the sweat of the brow is lessened by the conceptions of the brain. How exultant is the old Greek poet, Antipater,* when women are relieved of the drudgery of turning the grindstones for the daily supply of corn. "Woman! you who have hitherto had to grind corn, let your arms rest for the future. It is no longer for you that the birds announce by their songs the dawn of the morning. Ceres has ordered the *water-nymphs* to move the heavy millstones and perform your labour." Penelope had twelve slaves to grind corn for her small household. During the most prosperous time of Athens it was estimated that there were twenty slaves to each free citizen. Slaves are mere machines, and machines neither invent nor discover. The bondmen of the Jews, the helots of Sparta, the captive slaves of Rome, the serfs of Europe, and uneducated labourers of the present day who are the slaves of ignorance have added nothing to human progress. But as natural forces substitute and become cheaper than slave labour, liberty follows advancing civilisation. Machines require educated superintendence. One shoe factory in Boston by its machines does the work of thirty thousand shoemakers in Paris, who have still to go through the weary drudgery of mechanical labour. The steam power of the world, during the last twenty years, has risen from 11½ million to 29 million horse-power, or 152 per cent.

* "Analecta Veterum Græcorum, Epig. 39, vol. ii., p. 119.

Let me take a single example of how even a petty manufacture improved by the teachings of science affects the comforts and enlarges the resources of mankind. When I was a boy the only way of obtaining a light was by the tinder-box, with its quadruple materials, flint and steel, burnt rags or tinder, and a sulphur-match. If everything went well, if the box could be found and the air was dry, a light could be obtained in two minutes; but very often the time occupied was much longer, and the process became a great trial to the serenity of temper. The consequence of this was that a fire or a burning lamp was kept alight through the day. Old Gerard, in his "Herbal," tells us how certain Fungi were used to carry fire from one part of the country to the other. The tinder-box long held its position as a great discovery in the arts. The *Pyxidicula Igniaria* of the Romans appears to have been much the same implement, though a little ruder than the flint and steel which Philip the Good put into the collar of the Golden Fleece in 1429, as a representation of high knowledge in the progress of the arts. It continued to prevail till 1833, when phosphorus-matches were introduced, though I have been amused to find that there are a few venerable ancients in London who still stick to the tinder-box, and for whom a few shops keep a small supply. Phosphorus was no new discovery, for it had been obtained by an Arabian called Bechel in the eighth century. However, it was forgotten, and was re-discovered by Brandt, who made it out of very stinking materials in 1669. Other discoveries had, however, to be made before it could be used for lucifer-matches. The science of combustion was only developed on the discovery of oxygen a century later. Time had to elapse before chemical analysis showed the kind of bodies which could be added to phosphorus so as to make it ignite readily. So it was not till 1833 that matches became a partial success. Intolerably bad they then were, dangerously inflammable, horribly poisonous to the makers, and injurious to the lungs of the consumers. It required another discovery by Schrötter, in 1845, to change poisonous waxy into innocuous red-brick phosphorus, in order that these defects might be remedied, and to give us the safety-match of the present day. Now what have these successive discoveries in science done for the nation, in this single manufacture, by an economy of time? If before 1833 we had made the same demands for light that we now do, when we daily consume eight matches per head of the population, the tinder-box could have supplied the demand under the most favourable conditions by an expenditure of one quarter of an hour. The lucifer-match supplies a light in fifteen seconds on each occasion, or in two minutes for the whole day. Putting these differences into a year, the venerable ancient who still sticks to his tinder-box would require to spend ninety hours yearly in the production of light, while the user of lucifer-matches spends twelve hours; so that the latter has an economy of seventy-eight hours yearly, or about ten working days. Measured by cost of production at one shilling and sixpence daily, the economy of time represented in money to our population is twenty-six millions of pounds annually. This is a curious instance of the manner in which science leads to economy of time and wealth even in a small manufacture. In larger industries the economy of time and labour produced by the application of scientific discoveries is beyond all measurement. Thus the discovery of latent heat by Black led to the inventions of Watt; while that of the mechanical equivalent of heat by Joule has been the basis of the progressive improvements in the steam-engine which enables power to be obtained by a consumption of fuel less than one-fourth the amount used twenty years ago. It may be that the engines of Watt and Stephenson will yield in their turn to more economical motors; still they have already expanded the wealth, resources, and even the territories of England more than all the battles fought by her soldiers or all the treaties negotiated by her diplomatists.

The coal which has hitherto been the chief source of

power probably represents the product of five or six million years during which the sun shone upon the plants of the carboniferous period, and stored up its energy in this convenient form. But we are using this conserved force wastefully and prodigally; for although horse power in steam engines has so largely increased since 1864, two men only now produce what three men did at that date. It is only three hundred years since we became a manufacturing country. According to Professor Dewar, in less than two hundred years more the coal of this country will be wholly exhausted, and in half that time will be difficult to procure. Our not very distant descendants will have to face the problem—What will be the condition of England without coal? The answer to that question depends upon the intellectual development of the nation at that time. The value of the intellectual factor of production is continually increasing; while the values of raw material and fuel are lessening factors. It may be that when the dreaded time of exhausted fuel has arrived, its importation from other coal-fields, such as those of New South Wales, will be so easy and cheap that the increased technical education of our operatives may largely overbalance the disadvantages of increased cost in fuel. But this supposes that future Governments in England will have more enlightened views as to the value of science than past Governments have possessed.

Industrial applications are but the overflowings of science welling over from the fulness of its measure. Few would ask now, as was constantly done a few years ago, "What is the use of an abstract discovery in science?" Faraday once answered this question by another, "What is the use of a baby?" Yet round that baby centre all the hopes and sentiments of its parents, and even the interests of the State, which interferes in its upbringing so as to ensure it being a capable citizen. The processes of mind which produce a discovery or an invention are rarely associated in the same person, for while the discoverer seeks to explain causes and the relations of phenomena, the inventor aims at producing new effects, or at least of obtaining them in a novel and efficient way. In this the inventor may sometimes succeed without much knowledge of science, though his labours are infinitely more productive when he understands the causes of the effects which he desires to produce.

A nation in its industrial progress, when the competition of the world is keen, cannot stand still. Three conditions only are possible for it. It may go forward, retrograde, or perish. Its extinction as a great nation follows its neglect of higher education, for, as described in the proverb of Solomon, "They that hate instruction love death." In sociology, as in biology, there are three states. The first of balance, when things grow neither better nor worse; the second that of elaboration or evolution, as we see it when animals adapt themselves to their environments; and third, that of degeneration, when they rapidly lose the ground they have made. For a nation, a state of balance is only possible in the early stage of its existence, but it is impossible when its environments are constantly changing.

The possession of the raw materials of industry and the existence of a surplus population are important factors for the growth of manufactures in the early history of a nation, but afterwards they are bound up with another factor—the application of intellect to their development. England could not be called a manufacturing nation till the Elizabethan age. No doubt coal, iron, and wood were in abundance, though, in the reign of the Plantagenets, they produced little prosperity. Wool was sent to Flanders to be manufactured, for England then stood to Holland as Australia now does to Yorkshire. The political crimes of Spain from the reign of Ferdinand and Isabella to that of Philip III. destroyed it as a great manufacturing nation, and indirectly led to England taking its position. Spain, through the activity and science of the Arabian intellect, had acquired many important industries. The Moors and the Moriscos, who had been in Spain for a period as long

as from the Norman Conquest of this country to the present date, were banished, and with them departed the intellect of Spain. Then the invasion of the Low Countries by Philip II. drove the Flemish manufacturers to England, while the French persecution of the Huguenots added new manufacturing experience, and with them came the industries of cotton, wool, and silk. Cotton mixed with linen and wool became freely used, but it was only from 1738 to the end of the century that the inventions of Wyatt, Arkwright, Hargreaves, Compton, and Cartwright started the wonderful modern development. The raw cotton was imported from India or America, but that fact as regards cost was a small factor in comparison with the intellect required to convert it into a utility. Science has in the last hundred years altered altogether the old conditions of industrial competition. She has taught the rigid metals to convey and record our thoughts even to the most distant lands, and, within less limits, to reproduce our speech. This marvellous application of electricity has diminished the cares and responsibilities of Governments, while it has at the same time altered the whole practice of commerce. To England steam and electricity have been of incalculable advantage. The ocean, which once made the country insular and isolated, is now the very life-blood of England and of the greater England beyond the seas. As in the human body the blood bathes all its parts, and through its travelling corpuscles carries force to all its members, so in the body politic of England and its pelagic extensions steam has become the circulatory and electricity the nervous system. The colonies, being young countries, value their raw materials as their chief sources of wealth. When they become older they will discover it is not in these, but in the culture of scientific intellect that their future prosperity depends. Older nations recognise this as the law of progress more than we do; or, as Jules Simon tersely puts it—"That nation which most educates her people will become the greatest nation, if not to-day, certainly to-morrow." Higher education is the condition of higher prosperity, and the nation which neglects to develop the intellectual factor of production must degenerate, for it cannot stand still. If we felt compelled to adopt the test of science given by Comte, that its value must be measured by fecundity, it might be prudent to claim industrial inventions as the immediate fruit of the tree of science, though only fruit which the prolific tree has shed. But the test is untrue in the sense indicated, or rather the fruit, according to the simile of Bacon, is like the golden apples which Aphrodite gave to the suitor of Atalanta, who lagged in his course by stooping to pick them up, and so lost the race. The true cultivators of the tree of science must seek their own reward by seeing it flourish, and let others devote their attention to the possible practical advantages which may result from their labours.

There is, however, one intimate connection between science and industry which I hope will be more intimate as scientific education becomes more prevalent in our schools and universities. Abstract science depends on the support of men of leisure, either themselves possessing or having provided for them the means of living without entering into the pursuits of active industry. The pursuit of science requires a superfluity of wealth in a community beyond the needs of ordinary life. Such superfluity is also necessary for art, though a picture or a statue is a saleable commodity, while an abstract discovery in science has no immediate or, as regards the discoverer, proximate commercial value. In Greece, when philosophical and scientific speculation was at its highest point, and when education was conducted in its own vernacular and not through dead languages, science, industry, and commerce were actively prosperous. Corinth carried on the manufactures of Birmingham and Sheffield, while Athens combined those of Leeds, Staffordshire, and London, for it had woollen manufactures, potteries, gold and silver work, as well as ship-building. Their philosophers were the sons of burghers, and sometimes carried on the

trades of their fathers. Thales was a travelling oil merchant, who brought back science as well as oil from Egypt. Solon and his great descendant Plato, as well as Zeno, were men of commerce. Socrates was a stonemason; Thucydides a gold-miner; Aristotle kept a druggist's shop until Alexander endowed him with the wealth of Asia. All but Socrates had a superfluity of wealth, and he was supported by that of others. Now if our universities and schools created that love of science which a broad education would surely inspire, our men of riches and leisure who advance the boundaries of scientific knowledge could not be counted on the fingers as they now are, when we think of Boyle, Cavendish, Napier, Lyell, Murchison, and Darwin, but would be as numerous as our statesmen and orators. Statesmen, without a following of the people who share their views and back their work, would be feeble indeed. But while England has never lacked leaders in science, they have too few followers to risk a rapid march. We might create an army to support our generals in science, as Germany has done, and as France is now doing, if education in this country would only mould itself to the needs of a scientific age. It is with this feeling that Horace Mann wrote:—"The action of the mind is like the action of fire; one billet of wood will hardly burn alone, though as dry as the sun and north-west wind can make it, and though placed in a current of air; ten such billets will burn well together, but a hundred will create a heat fifty times as intense as ten—will make a current of air to fan their own flame, and consume even greenness itself."

VI. *Abstract Science the Condition for Progress.*

The subject of my address has been the relations of science to the public weal. That is a very old subject to select for the year 1885. I began it by quoting the words of an illustrious prince, the consort of our Queen, who addressed us on the same subject from this platform twenty-six years. But he was not the first prince who saw how closely science is bound up with the welfare of States. Ali, the son-in-law of Mahomet, the fourth successor to the Caliphate, urged upon his followers that men of science and their disciples give security to human progress. Ali loved to say, "Eminence in science is the highest of honours," and "He dies not who gives life to learning." In addressing you upon texts such as these, my purpose was to show how unwise it is for England to lag in the onward march of science when most other European Powers are using the resources of their States to promote higher education and to advance the boundaries of knowledge. English Governments alone fail to grasp the fact that the competition of the world has become a competition in intellect. Much of this indifference is due to our systems of education. I have ill fulfilled my purpose if, in claiming for science a larger share in public education, I have in any way depreciated literature, art, or philosophy, for every subject which adds to culture aids in human development. I only contend that in public education there should be a free play to the scientific faculty, so that the youths who possess it should learn the richness of their possession during the educative process. The same faculties which make a man great in any walk of life—strong love of truth, high imagination tempered by judgment, a vivid memory which can co-ordinate other facts with those under immediate consideration—all these are qualities which the poet, the philosopher, the man of literature, and the man of science equally require and should cultivate through all parts of their education as well as in their future careers. My contention is that science should not be practically shut out from the view of a youth while his education is in progress, for the public weal requires that a large number of scientific men should belong to the community. This is necessary because science has impressed its character upon the age in which we live, and as science is not stationary but progressive, men are required to advance its boundaries, acting as pioneers in the onward march of

States. Human progress is so identified with scientific thought, both in its conception and realisation, that it seems as if they were alternative terms in the history of civilisation. In literature, and even in art, a standard of excellence has been attained which we are content to imitate because we have been unable to surpass. But there is no such standard in science. Formerly, when the dark cloud was being dissipated which had obscured the learning of Greece and Rome, the diffusion of literature or the discovery of lost authors had a marked influence on advancing civilisation. Now, a Chrysoloras might teach Greek in the Italian universities without hastening sensibly the onward march of Italy; a Poggio might discover copies of Lucretius and Quintilian without exercising a tithe of the influence on modern life that an invention by Stephenson or Wheatstone would produce. Nevertheless, the divorce of culture and science, which the present state of education in this country tends to produce, is deeply to be deplored, because a cultured intelligence adds greatly to the development of the scientific faculty. My argument is that no amount of learning without science suffices in the present state of the world to put us in a position which will enable England to keep ahead or even on a level with foreign nations as regards knowledge and its applications to the utilities of life. Take the example of any man of learning, and see how soon the direct consequences resulting from it disappear in the life of a nation, while the discoveries of a man of science remain productive amid all the shocks of empire. As I am in Aberdeen I remember that the learned Dutchman Erasmus was introduced to England by the encouragement which he received from Hector Boece, the Principal of King's College in this University. Yet even in the case of Erasmus—who taught Greek at Cambridge and did so much for the revival of classical literature as well as in the promotion of spiritual freedom—how little has civilisation to ascribe to him in comparison with the discoveries of two other Cambridge men, Newton and Cavendish. The discoveries of Newton will influence the destinies of mankind to the end of the world. When he established the laws by which the motions of the great masses of matter in the universe are governed, he conferred an incalculable benefit upon the intellectual development of the human race. No great discovery flashes upon the world at once, and therefore Pope's lines on Newton are only a poetic fancy:—

Nature and Nature's laws lay hid in night,
God said, "Let Newton be," and all was light.

No doubt the road upon which he travelled had been long in preparation by other men. The exact observations of Tycho Brahe, coupled with the discoveries of Copernicus, Kepler, and Galileo, had already broken down the authority of Aristotle and weakened that of the Church. But though the conceptions of the universe were thus broadened, mankind had not yet rid themselves of the idea that the powers of the universe were still regulated by spirits or special providences. Even Kepler moved the planets by spirits, and it took some time to knock these celestial steersmen on the head. Descartes, who really did so much by his writings to force the conclusion that the planetary movements should be dealt with as an ordinary problem in mechanics, looked upon the universe as a machine, the wheels of which were kept in motion by the unceasing exercise of a divine power. Yet such theories were only an attempt to regulate the universe by celestial intelligences like our own, and by standards within our reach. It required the discovery of an all-pervading law, universal throughout all space, to enlarge the thoughts of men, and one which, while it widened the conceptions of the universe, reduced the earth and solar system to true dimensions. It is by the investigation of the finite on all sides that we obtain a higher conception of the infinite—

Willst du ins Unendliche schreiten,
Geh nur im Endlichen nach allen Seiten.

Ecclesiastical authority had been already undermined by earnest inquirers such as Wycliffe and Huss before Luther

shook the pillars of the Vatican. They were removers of abuses, but were confined within the circles of their own beliefs. Newton's discovery cast men's minds into an entirely new mould, and levelled many barriers to human progress. This intellectual result was vastly more important than the practical advantages of the discovery. It is true that navigation and commerce mightily benefited by our better knowledge of the motions of the heavenly bodies. Still, these benefits to humanity are incomparably less in the history of progress than the expansion of the human intellect which followed the withdrawal of the cramps that confined it. Truth was now able to discard authority, and marched forward without hindrance. Before this point was reached Bruno had been burned, Galileo had abjured, and both Copernicus and Descartes had kept back their writings for fear of offending the Church.

The recent acceptance of evolution in biology has had a like effect in producing a far profounder intellectual change in human thought than any mere impulse of industrial development. Already its application to sociology and education is recognised, but that is of less import to human progress than the broadening of our views of Nature.

Abstract discovery in science is then the true foundation upon which the superstructure of modern civilisation is built; and the man who would take part in it should study science, and if he can advance it for its own sake and not for its applications. Ignorance may walk in the path lighted by advancing knowledge, but she is unable to follow when science passes her, for, like the foolish virgin, she has no oil in her lamp.

An established truth in science is like the constitution of an atom in matter—something so fixed in the order of things that it has become independent of further dangers in the struggle for existence. The sum of such truths forms the intellectual treasure which descends to each generation in hereditary succession. Though the discoverer of a new truth is a benefactor to humanity, he can give little to futurity in comparison with the wealth of knowledge which he inherited from the past. We, in our generation, should appreciate and use our great possessions—

For me your tributary stores combine,
Creation's heir; the world, the world is mine.

ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.*

By Prof. HENRY E. ARMSTRONG, Ph.D., F.R.S., Sec. C.S.,
President of the Section.

In the Chemical Section of the British Association for the Advancement of Science the advancement of Chemistry throughout the British Empire must be a subject of commanding interest. Signs of such advancement are not wanting:—The rapid establishment of science colleges in one after another of our large towns; the establishment of the Society of Chemical Industry, which now, only in the fifth year of its existence, numbers over 2000 members; the granting of a Royal Charter to the Institute of Chemistry; the changes introduced at the London University in the regulations for the D.Sc. degree; the report of the Royal Commission on Technical Education, in which the value to chemical manufacturers of advanced chemical knowledge is so fully recognised; the important conference on education held at the Health Exhibition last year; the recent agitation to found a teaching university in London with adequate provision for research—surely all these are signs that the value of higher education must and will, ere long, be generally recognised.

The neglect of chemical research in our British schools

* Read Thursday, September 10, 1885.

has often been forcibly commented upon—of late, especially, by an eminent past-President of this Section, Dr. Perkin, whose opinion is of peculiar value, as he is not only world renowned as a chemist, but also as a manufacturer; indeed, as the founder of two distinct important chemical industries. There can be no doubt of the fact and of the dire consequences to our country of such neglect: how is it, then, that such pronounced complaints have been so coldly received; that hitherto they have produced comparatively so little effect; and that such slight encouragement is being given to those who, notwithstanding the many difficulties in their way, have steadfastly devoted themselves to research work? I question whether the value of such work has yet been brought home to teachers generally, let alone the public; the "*cui bono?*" cry is almost invariably met by pointing to some discovery of great pecuniary value as the outcome of research. This argument educationalists very properly refuse to recognise. Too little has been said as to the cause of the neglect so bitterly and properly complained of. Hence it is that I propose again to take up what many may regard as a somewhat threadbare theme.

Everyone will agree with Prof. Sir Henry Roscoe, who in his Address last year to this Section said "that those who are to become either scientific or industrial chemists should receive as sound and extensive a foundation in the theory and practice of chemical science as their time and abilities will allow, rather than they should be *forced prematurely*"—the italics are mine—"into the preparation of a new series of homologous compounds, or the investigation of some special reaction, or of some possible new colouring-matter, though such work might doubtless lead to publication." We must also all cordially agree with him that the aim should be, as he tells us his has been, "to prepare a young man by a careful and fairly complete general training to fill with intelligence and success a post either as teacher or industrial chemist, rather than to turn out mere specialists, who, placed under other conditions than those to which they have been accustomed, are unable to get out of the narrow groove in which they have been trained." If it were necessary to show that Sir Henry Roscoe is a believer in research in its proper place, ample proof would be afforded by his statement "that, far from underrating the educational advantages of working at original subjects, he considers this sort of training of the highest and best kind, but only useful when founded upon a sound and general basis."

But I venture to think that something has to be added in order to completely define the position of those who deplore the slight amount of original work which is being done in British laboratories. We maintain that no one can really "*fill with intelligence and success* a post either as teacher or industrial chemist" who has not been trained in the methods of research; and that, owing to the neglect of research, the majority of students are of necessity trained in a narrow groove. The true teacher and the industrial chemist are daily called upon to exercise precisely those faculties which are developed in the course of original investigation, and which it is barely possible—many would say, perhaps with justice, it is impossible—to sufficiently cultivate in any other manner. In a works the chemist is scarcely required as long as all goes well. The quality of the materials used or produced can be controlled by purely routine processes of analysis by the works analyst, or by well-trained laboratory boys. But things never do go well for any long period of time; difficulties are always arising; obscure points have to be investigated; and, if the manufacturer understand his business, improvements have to be effected,—which cannot be done unless the conditions under which he is working be understood, as well as the character of the changes which are taking place. Investigation is therefore necessary at every step. No amount of instruction, such as is ordinarily given, in the mere theory and practice of chemical science will confer the habits of mind, the acuteness of vision, and resourcefulness required of an

efficient chemist in a works, any more than the mere placing of the best tools in a workman's hands will make him a skilful operator.

Such being our position, we maintain that it is essential to make research an integral portion of the student's course in every college which pretends to *educate chemists*. It will not suffice occasionally to set a promising student to investigate, but a number of students, as well as the staff, must always be engaged in original work: in fact *an atmosphere of research must pervade the college*. It cannot be too clearly recognised that it is this which characterises and distinguishes the German schools at the present time. The student does not learn so much from the one special piece of work with which he is occupied, but a number of his fellow-students being also similarly engaged, the spirit of inquiry is rife throughout the laboratory: original literature is freely consulted, and they thus become acquainted with the methods of the old masters; vigorous discussions take place, not only in the laboratory, but also at that most useful institution, the "Kneipe"; the appearance of each new number of the scientific periodicals is keenly welcomed: in fact, a proper spirit of inquisitiveness is awakened and maintained, until it gradually becomes a habit. Probably there is less actual routine teaching done by the staff in the German schools than in our own. I am proud to own my indebtedness to one of them, and I can without hesitation say that I never truly realised what constituted the *science* of chemistry until I came under its influence.

But to realise the state which I have pictured—to *create an atmosphere of research in our science colleges in order that it may be possible for our students to obtain complete training in the industry*—several things are required. In the first place, it will be necessary that the students come to them better prepared than they are at present: as a rule they are so ill-prepared that it is very difficult, if not impossible, in the time at disposal, to give such preliminary instruction as is indispensable before higher work can be attempted. Their mathematical knowledge is so ill-digested that it is more often than not necessary to begin by teaching simple proportion, and they look aghast at a logarithm table. They cannot draw,—so far have we advanced in our civilisation that the subject is more often than not an "extra" in our schools. They understand a little French; but German, which may almost be called the language of modern science, is indeed an unknown tongue to them. I do not complain of their want of knowledge of science subjects, but of the unscientific manner in which they have been trained at school, and especially of the manner in which their intellectual faculties have become deadened from want of exercise, instead of developed and sharpened. Too many have never acquired the habit of working steadily and seriously; they have not learnt to appreciate the holiness of work,* so that they render the office of teacher akin to that of slave driver instead of to that of friend. What is perhaps worst is their marked inability, often amounting to downright refusal, either to take proper notice of what happens in an experiment or to draw any logical conclusion from an observation. Man is said to be a reasoning being, but my experience as an examiner and teacher would lead me to believe that this fact is altogether lost sight of by the average schoolmaster, who appears to confine himself almost exclusively to the teaching of hard dry facts, and makes no attempt to cultivate those very faculties which are supposed to characterise the human race; or he is so ill-prepared for his work that he fails to understand his duty. These are harsh words, but the evil is of such magnitude that it cannot be too plainly stated: those who, like myself, are brought full face to it fail in their duty if,

* In my experience, the behaviour of ordinary day male students is, in this respect, particularly striking in comparison with that of female and evening students: the evening students, who come with a desire to learn, and the female students are invariably most attentive, and make the fullest use of the opportunities afforded them.

when opportunity occurs, they do not take occasion to call attention to its existence.

Probably the only remedy—certainly the most effectual, and that which can be most easily applied—is the introduction of a *rational system* of practical science teaching into all our schools, whatever their grade; one effect would be that all the school subjects would of necessity soon be taught in a more scientific manner. I am not one of those who would eschew the teaching of classics, and I do not wish to see science teaching introduced into schools generally, in order that the students who come to me may already have gained some knowledge of science: under existing circumstances I prefer that they shall not; but I desire its introduction because the faculty of observing and of reasoning from observation, and also from experiment, is most readily developed by the study of experimental science: this faculty, which is of such enormous practical value throughout life, being, I believe,—as I have said elsewhere,—left uncultivated after the most careful mathematical and literary training. No one has stated this more clearly than Charles Kingsley. We are told that, speaking to the boys at Wellington College, he said:—"The first thing for a boy to learn, after obedience and morality, is a habit of observation—a habit of using his eyes. It matters little what you use them on, provided you do use them. They say knowledge is power, and so it is—but only the knowledge which you get by observation. Many a man is very learned in books, and has read for years and years, and yet he is useless. He knows *about* all sorts of things, but he can't *do* them." This is precisely our complaint; the average schoolboy may know a good deal *about* things, but he can't *do* them. The ordinary school system of training does not, in fact, develop the "wits," to use a popular and expressive term for the observing and reasoning faculties; but it is certain that the wits require training. It is because the teaching of experimental science tends to develop the wits that those among us who know its power are so anxious for its introduction. This cannot be too clearly stated, the popular view—to judge from newspaper discussions—being apparently that science is to be classed with "extras"; that it is good for those who can afford it, but can be dispensed with by those who cannot. This undoubtedly is true of the "science" which is taught the specialist, and I fear even much of the "science" which is at present taught in schools. Let us hope that ere long other views will prevail, when the object which it is sought to gain by teaching science is made clear.

While blaming the schoolmaster for his neglect, it must not be forgotten that the teaching of sciences in schools meets with comparatively little encouragement at the hands of our examining bodies and the universities. Again, examinations are too often entrusted to those who have no educational experience, and with most unfortunate results: in no case, probably, is inexperience so inexcusable as in an examiner. Too often, also, the examinations are in the hands of pure specialists, who take too formal a view of their duty, and expect from boys and girls at school as much as from their own students, who are older and devote more time to the work. Such examiners are prone to discourage science by marking too severely; and as their questions govern the teaching, instruction is given in schools without due reference to educational requirements, and in a purely technical style: this, I fear, is the effect of some of the universities' local examinations.

I have it on good authority that the recent changes in the scheme of the examinations for admission at Sandhurst have forced one large school, well known for the attention paid in it to the teaching of science, to cease to give instruction in science to those of its pupils who propose to compete at these examinations, at once on their deciding to do so. Then, not only are the science scholarships at the universities few in proportion, but the great majority of students pass through their university career without being called upon to gain the slightest knowledge of physical science: yet, more often than not, the teachers

are chosen from these. A large proportion become clergymen, and considering the demands upon them and the unbounded opportunities which they have of imparting useful information, there cannot be a doubt that to no other class of the community is a knowledge of natural science likely to be of more value.* Let us hope that the time is near when our universities will no longer be open to this reproach.† Whatever steps they may elect to take it is before all things important that it be not forgotten that their main purpose must be to influence the schools, so that experimental science may be used as an educational weapon at the most appropriate time, and not when the faculties to be fashioned by it have become atrophied through neglect, as I fear is too often the case, ere the university is reached.

We must carefully guard against being satisfied with the mere introduction of one or more science subjects into the school curriculum: some of those who strenuously advocate the introduction of science teaching perhaps do not sufficiently bear this in mind. Chemistry, physics, &c., may be—and I fear are, more often than not—taught in such a way that it were better had no attempt whatever been made to teach them. I hold that it is of no use merely to set lads to prepare oxygen, &c., or to make experiments which please them in proportion as they more nearly resemble fireworks; and it is not the duty of the schoolmaster to train his boys as though they were to become chemists, any more than it is his duty to fit them to enter any other particular profession or trade: the whole of the science teaching in a school should be subservient to the one object of developing certain faculties. Unfortunately too great difficulties stand in the way at present—viz., the want of suitable books and of a rational system of teaching science from the point of view here advocated; and the requirements of the universities and other examining bodies. Both books and examinations are of too special a character: they may suit the specialist, but do not meet educational requirements. I have already somewhat fully expressed my views on this subject in a paper read at the Educational Conference in London last year. Although much more might be said, I will only now call attention to the important service which we may render in removing these difficulties.

The reform most urgently needed, in which, as members of the community, not merely as chemists, we are all most interested, is the introduction of some system which will ensure a proper training for teachers. Engineers, lawyers, medical men, pharmacists, have severally associated themselves to found institutions which require those who desire to join the profession to obtain a certain qualification; even chemists are seeking to do this through the Institute of Chemistry. But schoolmasters, although members of what is probably the most responsible, onerous, useful, and honourable of any of the professions, have as yet neither made, nor shown any inclination to make, a united effort to ensure that all those who join their profession shall be properly qualified. Surely the time has come when the subject must receive full public attention; the country cannot much longer remain content that the education of all but those of its sons and daughters who come within the province of the School Board should be carried

* "I sometimes dream," said Kingsley, "of a day when it will be considered necessary that every candidate for ordination should be required to have passed creditably in at least one branch of physical science, if it be only to teach him the method of sound scientific thought."

† I learnt with the most lively satisfaction, but a few days ago, that Dr. Percival, the late head-master of Clifton College, speaking at a meeting of Convocation at Oxford last term, said: "If twenty years ago this university had said: from this time forward the elements of natural science shall take their place in responsions side by side with the elements of mathematics, and shall be equally obligatory, you would long ago have effected a revolution in school education." This remark elicited some warm expressions of approval. Dr. Percival, I am sure, has the cordial approval of all science teachers, and he will earn their gratitude, and deserve that of the public at large, if he can succeed in inducing his university to take action in accordance with his enlightened views.

on without any guarantee that it is being properly conducted.

Glaring as are the faults in the existing school system, and although it rests with the universities and other teaching and examining bodies—if the public do not intervene—to prescribe a proper course of instruction for potential schoolmasters and to enforce a rational system of training all the mental faculties, we science teachers may meanwhile do much by introducing more perfect methods into our own system of teaching. The students attending our courses belong to various classes; some will become chemists, and require the highest and most complete training; others will be teachers in colleges or schools; many will occupy themselves as consulting chemists or analysts; many others will have to take charge of manufacturing operations in which a knowledge of chemistry is of more or less direct importance and value; not a few will become medical men; and a large proportion, let us hope, will be those who have no direct use for chemistry, although the knowledge will be of great service to them in many ways: among such we may include architects and builders, engineers, farmers, and even country gentlemen. Have we sufficiently considered the several requirements of all these various classes? I submit, with all due deference, that we have not! Our attention has been too exclusively directed to the training up of the future analyst; the instruction has been of too technical a character.

I know it is rank heresy to say so, but I maintain that in future far less time must be devoted to the teaching of ordinary qualitative and quantitative analysis, and that *technical instruction* as now given in these subjects must find its place later in the course. Our main object in the first instance must be to fully develop the intellectual faculties of our students; to encourage their aspirations by inculcating broad and liberal views of our science, not an infinite number of petty details. We must not merely teach them the principles and main facts of our science, but we must show them how the knowledge of those facts and principles has been gained; and they must be so drilled as to have complete command of their knowledge. The great majority will not be required to perform *ordinary* analyses, either qualitative or quantitative; it will be sufficient for them to have gained such an amount of practical experience that they thoroughly understand the principles of analysis; that they shall have learnt to appreciate the sacredness of accuracy; and that they shall have acquired sufficient manipulative skill to be able when occasion requires to carry into execution the analytical process which their text books tell them is applicable, and even, if necessary, to modify the process to suit circumstances.

Chemistry is no longer a purely descriptive science. The study of carbon compounds and Mendeljeff's generalisation have produced a complete revolution! The faults in our present system are precisely those which have characterised the teaching of geography and history, and which are now becoming so generally recognised and condemned; in fact, no better statement of the manner in which I conceive chemistry should be taught could be given than by broadly applying to the teaching of chemistry what was said by Professor Seeley, at the International Conference on Education last year, in an important paper on the teaching of history.

The necessity for some change must, I venture to think, be patent to all thoughtful teachers, and especially to those who are called upon to fulfil the painful duties of an examiner. The railway book-stalls have made us acquainted with "Confessions" of all sorts, but if the "Confessions of an Examiner" were to be written they would be far more heartrending than any. The examiner in chemistry, let him go where he will, scarcely dare ask a question to which the answer cannot be directly read out from a text-book. He will be told "that such and such a compound is formed by the action of so and so upon upon so and so," but he will usually find blank ignorance of the phrase

"by the action of" and as to the mode of performing the operation. The examiner would, however, be bound to agree with the teacher that it is almost impossible to induce students to seek information outside the lecture-room, and except in the ordinary cram text-books, and that it is hopeless to expect them to devote attention to anything, unless it will pay in a subsequent examination—in fact that the old university spirit of acquiring knowledge for its own sake is almost unknown among our science students. Herein lies one of the teacher's most serious difficulties, as he is more often than not bound to teach in a particular way, or to teach certain subjects in entire opposition to his own views, in order to qualify his students to pass a particular examination: for example, many of our colleges now distinctly state that their courses are intended to qualify students to pass the examinations of the London University, and hence they are governed by the requirements of that university, which vary more or less as the examiners are periodically changed. The examiner, on the other hand, is often placed in a difficult position: it is clear to him that the system under which the students he is called upon to examine have been taught is a bad one: yet he feels that he has no right to set questions such as he honestly believes should direct the teaching into proper channels, because he knows that the teacher is immovable, and it is not fair to make the examinees the victims of a system for which they are not responsible. Hence, perforce, the teacher goes on teaching badly and the examiner examining badly. Difficulties of this kind are bound to make themselves felt at a transition period like the present, and will only disappear if we recognise the grave responsibility which rests upon ourselves and improve our methods of teaching and our text-books: these, in too many instances, are unsuited to modern requirements, and are being made worse by stereotyping, and the practice which is gradually creeping in of merely changing the date on the title-page and the numeral before the word "edition," thus engendering the belief that the information is given up to date.

Both in teaching and examining two important changes ought forthwith to be made: our students ought at the very beginning of their career to become familiar with the use of the balance; and the imaginary distinction between so-called inorganic and organic compounds should be altogether abandoned. I do not mean that students should be taught quantitative analysis as ordinarily understood, but that instead of endeavouring to make clear to them by explanation only the meaning of terms such as equivalent, for example, we should set them to perform a few simple quantitative exercises in determining equivalents, &c. It can easily be done, and terms which otherwise long remain mythical acquire a real meaning in the student's mind. That the elements of the chemistry of carbon compounds do not find a place at a very early period in the course of instruction is one of those riddles connected with our system which it is impossible to answer. Attention was once pithily directed to the fact in my hearing by a scientific friend—not a chemist—who said he had often felt astonished that, although he had learnt a good deal of chemistry, the chemistry of the breakfast-table was practically a sealed book to him, common salt being the one object of which he felt he knew something.

I may here urge that there is one great error which we *must* avoid in the future, that of overworking our students, in the sense of obliging them to pay attention to too many subjects at a time. This is done more or less, I believe, in all our science schools, and medical students are peculiarly unfortunate in this respect. It is to some extent necessitated by the deficient preliminary education of our students; but I believe that I am justified in stating that it is also partly, perhaps mainly, due to the fact that the curriculum is too often imposed by lecturers who are directly interested in the attendance of students at their lectures. This is one of the great difficulties in the way of higher education, and the continuance of the evil is

probably in a measure due to inappreciation of what constitutes higher education and culture: neither consist in a smattering of knowledge of a variety of subjects such as is too often required at present.

The more general appreciation of the value of science undoubtedly depends to a considerable extent on improvements such as I have indicated being introduced. When such is the case, we may hope that a large number of students will enter our chemical schools, not with the intention of becoming chemists, but because it will be recognised that the training there given is of high educational value, and that a knowledge of chemistry is of distinct service in very many avocations.

We may also hope that it will be possible ere long to teach chemistry properly to medical students. Seeing that the practice of medical men largely consists in pouring chemicals into that delicately organised vessel the human body, and that the chemical changes which thereupon take place, or which normally and abnormally occur in it, are certainly not more simple than those which take place in ordinary inert vessels in our laboratories, the necessity for the medical man to have a knowledge of chemistry—and that no slight one—would appear to ordinary minds to stand to reason; that such is not generally acknowledged to be the case can only be accounted for by the fact that they never yet have been taught chemistry, and that the apology for chemistry which has been forced upon them has been found to be of next to no value. No proof is required that the student has ever performed a single quantitative exercise; and I have no hesitation in saying that the examinations in so-called practical chemistry, even at the London University, are beneath contempt: after more than a dozen years' experience as a teacher under the system, I can affirm that the knowledge gained is of no permanent value, and the educational discipline *nil*. Here the reform must be effected by the examining boards: it is for them to insist upon a satisfactory preliminary training, and they must so order their demands as to enforce a proper system of practical teaching; and if chemistry is to be of real service to medical men more time must be devoted to its study. Physiological chemistry is taught nowhere in our country, either at the universities or at any of our great medical schools: let us hope that the publication of works like those of Gamgee and Lauder Brunton may have some effect in calling attention to this grievous neglect of so important a subject.

Having dealt with the educational aspect of the question, let me now briefly refer to some other difficulties which seriously hinder research. It has been more or less openly stated that the teachers in our chemical schools might themselves do far more. Is this the case? I do not think so; I believe it is not the staff, in most cases, who are primarily in fault. Under our peculiar system of placing the government of science schools in the hands of those who have little, if any, experience as educationalists and little knowledge of or sympathy with science, the appointments are sometimes made without the slightest reference to capability of inciting and conducting original investigation, and without any proof having been given even of a desire to promote higher education in the only possible way—by research; nevertheless, experience shows that, as a rule, fair use is made by teachers of their opportunities. The opportunities afforded us are indeed few. In the first place, the amount of actual routine teaching we are called upon to perform is very considerable, many of us having to conduct evening as well as day classes; and the work is often of the most harassing description, owing to the want of interest displayed by the students. The assistance provided is also too often inadequate, and much which should be done by assistants is therefore thrown upon the principals. Higher work under these conditions is practically out of the question, not so much because it is impossible to snatch at intervals a few hours per week, but because the attention is so much taken up in the preparation of lectures and laboratory and tutorial teaching that it is impossible to secure that free-

dom of mind and concentrated attention which are essential to the successful prosecution of research. Bad, however, as is often the position of the principals, that of the junior staff is usually far worse. During official hours they are entirely occupied in tutorial work, and what little energy remains must more often than not be devoted to coaching or literary work, to supplement the too modest income which the salary attached to their official position affords. Under these circumstances, it is remarkable that so much enthusiasm should prevail among them on the subject of research. The tradition which prevails in the German schools, that the junior staff are bound to find some time for original work, is almost unknown in this country, and too often difficulties are raised, rather than facilities afforded, when the desire is manifested: we do not, in fact, sufficiently honour the assistant as the potential professor. It has also often struck me as remarkable, and it must have struck others who understand the German system, that in this practical country we have not adapted that cheap luxury—the Privat-Dozent, who costs nothing and exercises a most important function in promoting higher education. The explanation of this and many other anomalies lies in the fact that very few among us realise what a university is: a clear exposition of the Scotch and German systems would be of great value in these days of new universities and university colleges.

I believe that in most, if not all, of the German chemical schools a private research assistant is placed at the disposal of the professor. Will this ever be the case here? The want of material assistance is not only felt in this respect, however: few of our chemical schools are really efficiently equipped; most of them are seriously in want of larger and more expensive apparatus, of suitable specimens, &c.; the annual grant barely suffices for the purchase of the ordinary chemicals and the payment of unavoidable current expenses, so that, as a rule, nothing remains to meet the expenses of research work—*i. e.*, of higher education. In point of fact, nearly all of those who are engaged in research are doing so at their own expense; important assistance, for which we cannot be too thankful, is indeed received from the various research funds, but the proportion which the grants bear to the total sum expended is not large. I am sure we all recognise that each one of us is bound, according to his abilities and the opportunities he has, to add to the stock of knowledge, and that the keenest intellectual pleasure is derived therefrom; but it must not be forgotten that the results we obtain are very rarely of immediate practical value, and that as a rule *we* reap no pecuniary advantage. I venture to think, in fact, that it is remarkable that so much, not that so little, is done, and that reproach rests very lightly upon the profession in this matter. Whether our national pride will prevent our being much longer beholden to foreigners for by far the greater number of new facts in chemistry is a difficult question to answer, and must rest with the public!

The occasions on which we teachers of science subjects are able to bear witness in public are of necessity few. Deeply sensible, not only of the honour, but also of the responsibility of my position as President of this Section, I felt that it was my duty to avail myself of this opportunity. Being a teacher who is interested in teaching; being convinced of the existence of most serious faults in our educational system; feeling that the present is a most critical period: I have not hesitated to speak very freely. Some of the difficulties to which I have referred might soon disappear if science teachers generally would agree to consider them together, and I believe that it would be a very great advantage if an association for the discussion of educational questions were formed of the staffs of our science colleges throughout the country. The special difficulties which surround our science colleges, and prevent them from exercising their full share of influence upon the advancement of our national prosperity might also be removed at no distant date; but I see only one way of accomplishing this, and I fear it will hardly

find favour: it is by their all becoming vested in the State. In this country we like to do things in our own way, and the objection will at once be raised that this would deprive all the colleges of their individuality, and would tend to crush originality and to stereotype teaching. If I thought so, I should never make the suggestion. But it would not, provided that complete academic freedom were secured to the staff, and each college were left to adjust itself to local requirements; efficiency would be maintained by the competition of the various colleges. Local enterprise, which has hitherto been trusted to, is clearly breaking down under the tremendous strain of modern educational requirements: some change must ere long be made.

I now pass to the consideration of a subject of special interest in this Section, which I think requires the immediate earnest attention of chemists and physicists combined—that of *Chemical Action*. In his Presidential Address to the Association last year, Professor Lord Rayleigh made only a brief reference to chemistry, but many of us must have felt that his few remarks were pregnant with meaning, especially his reference to the importance of the principle of the dissipation of energy in relation to chemical change. A year's reflection has led me to think them of peculiar weightiness and full of prophecy. I would especially draw attention to the closing paragraph of this portion of his address: "From the further study of electrolysis we may expect to gain improved views as to the nature of the chemical reactions, and of the forces concerned in bringing them about. I am not qualified—I wish I were—to speak to you on recent progress in general chemistry. Perhaps my feelings towards a first love may blind me, but I cannot help thinking that the next great advance, of which we have already some foreshadowing, will come on this side. And if I might, without presumption, venture a word of recommendation, it would be in favour of a more minute study of the simpler chemical phenomena."

Chemical action may be defined as being any action of which the consequence is an alteration in molecular constitution or composition; the action may concern molecules which are of only one kind—cases of mere decomposition, of isomeric change and of polymerisation; or it may take place between dissimilar molecules—cases of combination and of interchange. Hitherto it appears to have been commonly assumed and almost universally taught by chemists that action takes place directly between A and B, producing AB, or between AB and CD, producing AC and BD, for example. This, at all events, is the impression which the ordinary average student gains. Our text-books do not, in fact, as a rule, deign to notice observations of such fundamental importance as those of De La Rive on the behaviour of nearly pure zinc with dilute sulphuric acid, or the later ones of Faraday ("Exp. Researches," series vii., 1834, 863 *et seq.*) on the insolubility of amalgamated zinc in this acid. Belief in the equation $\text{Zn} + \text{H}_2\text{SO}_4 = \text{H}_2 + \text{ZnSO}_4$ hence becomes a part of the chemist's creed, and it is generally interpreted to mean that zinc *will* dissolve in sulphuric acid, forming zinc sulphate, not, as should be the case, that *when* zinc dissolves in sulphuric acid it produces zinc sulphate, &c. In studying the chemistry of carbon compounds, we become acquainted with a large number of instances in which a more or less minute quantity of a substance is capable of inducing change in the body or bodies with which it is associated without apparently itself being altered. The polymerisation of a number of cyanogen compounds and of aldehydes, the "condensation" of ketonic compounds and the hydrolysis of carbohydrates are cases in point; but so little has been done to ascertain the nature of the influence of the contact-substance, or *catalyst*, as I would term it, the main object in view being the study of the product of the reaction, that the importance of the catalyst is not duly appreciated. Recent discoveries, however—more particularly Mr. H. B. Dixon's

invaluable investigation on conditions of chemical change in gases, and the experiments of Mr. Cowper with chlorine and various metals, and of Mr. Baker on the combustion of carbon and phosphorus—must have given a rude shock, from which it can never recover, to the belief in the assumed simplicity of chemical change. The inference which I think may fairly be drawn from Mr. Baker's observations—that *pure* carbon and phosphorus are incombustible in *pure* oxygen—is indeed startling, and his experiments must do much to favour that "more minute study of the simpler chemical phenomena" so pertinently advocated by Lord Rayleigh.

But if it be a logical conclusion from the cases now known to us, that chemical action is not possible between any two substances other than elementary atoms, and that the presence of a third is necessary, what is the function of the third body—the catalyst, and what must be its character with reference to one or both of the two primary agents? In the discussion which took place at the Chemical Society after the reading of Mr. Baker's paper, I ventured to define chemical action as *reversed electrolysis*, stating that in any case in which chemical action was to take place it was essential that the system operated upon should contain a material of the nature of an electrolyte (*Chem. Soc. Proc.*, 1885, p. 40). In short, I believe that the conditions which obtain in any voltaic element are those which must be fulfilled in every case of chemical action. There is nothing new in this; in fact, it practically was stated by Faraday in 1848 ("Experimental Researches in Electricity," series vii. §§ 858, 859*); and had due heed been given to Faraday's teaching we should scarcely now be so ignorant as we are of the conditions of chemical change.

The questions—What is Electrolysis? What is an Electrolyte? are all-important to the chemist, if my contention be accepted. Moreover, the consideration of chemical action from this point of view almost of necessity obliges us also to consider what it is that constitutes chemical affinity. I will not presume to offer any opinion on this subject; but I would recall attention to the prominence which so great an authority as Helmholtz gave in the last Faraday Lecture (*Chem. Soc. Trans.*, 1881, 277) to the view held by Faraday, and which is so definitely stated in a passage in his "Experimental Researches"† (Series viii., 918, also 850 and 869).

Helmholtz used the words: "I think the facts leave no doubt that the very mightiest among the chemical forces are of electric origin. The atoms cling to their

* "Those bodies which, being interposed between the metals of the voltaic pile, render it active, are all of them electrolytes, and it cannot but press upon the attention of everyone engaged in considering this subject, that in those bodies (so essential to the pile) decomposition and the transmission of a current are so intimately connected that one cannot happen without the other. If, then, a voltaic trough have its extremities connected by a body capable of being decomposed, as water, we shall have a continuous current through the apparatus; and whilst it remains in this state we may look at the part where the acid is acting upon the plates and that where the current is acting upon the water as the reciprocals of each other. In both parts we have the two conditions, *inseparable in such bodies as these*, namely, the passing of a current and decomposition; and this is as true of the cells in the battery as of the water-cell; for no voltaic battery has as yet been constructed in which the chemical action is only that of combination: *decomposition is always included*, and is, I believe, an essential chemical part."

† "But the difference in the two parts of the connected battery—that is, the decomposition or acting cells—is simply this; in the former we urge the current through, but it, apparently of necessity, is accompanied by decomposition; in the latter we cause decompositions by ordinary chemical actions (*which are, however, themselves electrical*), and, as a consequence, have the electrical current; and as the decomposition dependent upon the current is definite in the former case, so is the current associated with the decomposition also definite in the latter."

‡ "All the facts show us that that power commonly called chemical affinity can be communicated to a distance through the metals and certain forms of carbon; that the electric current is only another form of the forces of chemical affinity; that its power is in proportion to the chemical affinities producing it; that when it is deficient in force it may be helped by calling in chemical aid, the want in the former being made up by an equivalent of the latter; that, in other words, the forces termed chemical affinity and electricity are one and the same."

electric charges, and opposite electric charges cling to each other; but I do not suppose that other molecular forces are excluded, working directly from atom to atom." In the passages which immediately follow, this physicist then makes several statements of extreme importance, which directly bear upon the subject I desire to discuss, and which, therefore, I quote.*

The interpretation of Faraday's law of electrolysis, which Helmholtz has brought under the notice of chemists, is of the most definite and far-reaching character. Does it, however, at all events in the form in which he has put it forward, accord sufficiently with the facts as these present themselves to the chemist's mind? All will recognise that the chemical changes effected by a current in a series of electrolytic cells are equivalent to those which take place within the voltaic cells wherein the current is generated; but in neither case is the action of a simple character: in both a variety of chemical changes takes place, the precise character of which is but imperfectly understood, and we are unable to assign numerical values, either in terms of heat or electrical units, to most of the *separate* changes. Moreover, many compounds are not electrolytes, while others which are regarded by the chemist as their analogues are very readily decomposed by a current of low E.M.F., although no great difference is to be observed in their "heats of formation"; liquid hydrogen chloride on the one hand, and fused silver chloride on the other, may be cited as examples. Again, how are we to interpret on this theory such changes as that involved in the conversion of stannic into stannous chloride? The former, I suppose, is to be regarded as consisting of an atom of quadrivalent tin charged with four units of, say, positive electricity, and of four atoms of univalent chlorine, each carrying a unit charge of negative electricity; on withdrawal of two of the chlorine atoms the residual SnCl_2 will have two free unit charges of positive electricity. We

know that when the temperature is sufficiently lowered two such residues unite, forming Sn_2Cl_4 , and it is not improbable that crystalline stannous chloride represents a still later stage of condensation. Is this compatible with the theory? That cases of this kind are contemplated would appear from the reference to "unsaturated compounds with an even number of unconnected units of affinity," which we are told may be charged with equal equivalents of opposite electricity; and also from the allusion to the existence of molecules of elementary substances composed of two atoms. It is more than probable that these anomalies would disappear on fuller statement of his views by the author of the theory: I have ventured to call attention to them in the hope of eliciting such statement.

Helmholtz tells us that electrolytes belong to the class of typical compounds, the constituents of which are united by "atomic affinities," not to the class of "molecular aggregates." Is this the fact? Before chemists can accept this conclusion many difficulties must be removed which appear to surround the question. In the first place it is in the highest degree remarkable that, with the one single exception of *liquefied ammonia, no known binary hydride is in the liquid state an electrolyte*: liquid hydrogen chloride, bromide, and iodide, for example, withstanding an E.M.F. of over 8000 volts (8040 De la Rue cells: Bleekrode). Water, again, according to Kohlrausch's most recent determinations, has an almost infinite resistance. Yet a mixture of hydrogen chloride and water readily conducts, and is electrolysed; an aqueous solution of sulphuric acid behaves similarly, although the acid itself has a very high resistance.* Very many similar examples might be quoted, but it is well known that aqueous solutions generally conduct more or less perfectly, and are electrolysed.†

The current belief among physicists would appear to be that the dissolved electrolyte—the acid or the salt—is almost exclusively primarily decomposed (Wiedemann, "Elektricität," 1883, ii., 924). We are commonly told that sulphuric acid is added to water to *make it conduct*, but the chemist desires to know why the solution becomes conducting. It may be that in all cases the "typical compound" is the actual electrolyte,—i.e., the body decomposed by the electric current,—but the action only takes place when the typical compounds are conjoined and form the molecular aggregate, for it is an undoubted fact that HCl and H_2SO_4 dissolve in water, forming "hydrates." This production of an "electrolytical system" from dielectrics is, I venture to think, the important question for chemists to consider. I do not believe that we shall be able to state the exact conditions under which chemical change will take place until a satisfactory solution has been found.

F. Kohlrausch (*Pogg. Ann.*, 1876, 159, 233) has shown that, on adding sulphuric acid to water, the electric conductivity increases very rapidly until when about 30 per cent of acid is present a maximum (6914) is attained; conductivity then diminishes almost as rapidly, and a minimum (913) is reached when the concentration corresponds with that of a monohydrate ($\text{H}_2\text{SO}_4\cdot\text{OH}_2$); from this point conductivity increases somewhat (to 1031 at 92.1 per cent H_2SO_4), and then again falls, and is pro-

* "Several of our leading chemists have lately begun to distinguish two classes of compounds—viz., molecular aggregates and typical compounds, the latter being united by atomic affinities, the former not. Electrolytes belong to the latter class. If we conclude from the facts that every unit of affinity is charged with one equivalent, either of positive or of negative electricity, they can form compounds, being electrically neutral, only if every unit charged, positively unites under the influence of a mighty electric attraction with another unit charged negatively. You see that this ought to produce compounds in which every unit of affinity of every atom is connected with one, and only one, other unit of another atom. This, as you will see immediately, is the modern chemical theory of quantivalence, comprising all the saturated compounds. The fact that even elementary substances, with few exceptions, have molecules composed of two atoms makes it probable that even in these cases electric neutralisation is produced by the combination of two atoms, each charged with its full electric equivalent, not by neutralisation of every single unit of affinity. Unsaturated compounds with an even number of unconnected units of affinity offer no objection to such an hypothesis; they may be charged with equal equivalents of opposite electricity. Unsaturated compounds with one unconnected unit, existing only at high temperatures, may be explained as dissociated by intense molecular motion of heat, in spite of their electric attractions. But there remains one single instance of a compound which, according to the law of Avogadro, must be considered as unsaturated even at the lowest temperature—namely, nitric oxide (NO), a substance offering several very uncommon peculiarities, the behaviour of which will be perhaps explained by future researches." The popular mistake is here made of assuming that elementary substances, with few exceptions, have molecules composed of two atoms. We now know considerably over seventy elements, but of these the molecular weights in the gaseous state of only thirteen have been satisfactorily determined. The gaseous elements hydrogen, oxygen, nitrogen, and chlorine, and also bromine, iodine, and tellurium, have diatomic molecules; phosphorus and arsenic have tetraatomic molecules; those of sulphur are hexatomic, and selenium molecules are probably of similar constitution, but more readily broken down than those of sulphur; lastly, cadmium and mercury molecules are monatomic. It is more than probable that carbon, and also silicon and boron, form highly complex molecules. Of the remaining undetermined elements, the greater number are metals, and it is not unreasonable to assume that many of these will be found to resemble cadmium and mercury in molecular composition. It is clear, however, that at present we have no right to say that the elementary molecules are, as a rule, diatomic. It would assist in removing this error if chemists would consistently place *after* the symbol the numeral indicating the "atomicity" of the elementary molecule—thus, Hg_1 , Cd_1 , C_2 ; and if in all cases when a numeral is absent, or is placed *before* the symbol, it were understood that advisedly no indication of the molecular state afforded.

* It is more than probable that the most nearly pure sulphuric acid which can be obtained is not homogeneous, but is at least a mixture of H_2SO_4 , $\text{H}_2\text{S}_2\text{O}_7$, and "hydrated compounds" in proportions depending on the temperature, and hence that (pure) sulphuric acid, H_2SO_4 , like water, would behave as a dielectric.

† On the other hand, it is remarkable that, whereas liquefied ammonia may be electrolysed, an aqueous solution of ammonia is a most imperfect conductor (Faraday, F. Kohlrausch), although solutions of ammonium salts compare favourably in conductivity with corresponding sodium and potassium salts. This fact serves somewhat to allay the suspicion that Bleekrode did not take sufficient precautions to dry the ammonia; but his result cannot, I think, be accepted as final, on account of the relatively high E.M.F. required, and the repetition of the experiment, with every precaution to ensure purity of the gas, is most important. Faraday regarded the decomposition of ammonia on electrolysis of its solution as merely the result of a secondary action.

bably zero for the pure acid: on adding sulphuric anhydride to the acid conductivity again increases. Solutions of other acids and of a number of salts—chiefly deliquescent and very soluble salts—also exhibit maximum conductivity at particular degrees of concentration. In no other case has the existence of two maxima, such as are observed in solutions of sulphuric acid, been established; but probably this is because the experiments either have not been, or cannot well be, carried out with pure substances or very concentrated solutions. Solutions of less soluble salts increase in conductivity as the amount of salt dissolved increases.

Kohlrausch has suggested, as an explanation of the influence of the "solvent" on the conductivity of an "electrolyte," that in a solution the ions which are being transferred electrolytically come less frequently into collision than would be the case in the pure substance. There is therefore less opportunity for the formation of new molecules, and the ions are able to travel farther before entering into combination.

Regarding the question from a chemist's point of view, however, I cannot help thinking that this explanation is scarcely satisfactory or sufficient; and I cannot resist the feeling that the production of electrolytically conducting solutions from dielectrics is in some manner dependent upon the occurrence of chemical action. If the composition of the solutions of maximum conductivity be calculated,* it will be seen that they contain but a limited number of water molecules; thus the solution of sulphuric acid of maximum conductivity (at 18°) contains 30.4 per cent. of acid, and therefore has the composition $\text{H}_2\text{SO}_4 : 12.4 \text{ H}_2\text{O}$ (approximately); for nitric acid the ratio is 1 : 8; for acetic acid it is about 1 : 17. Now it is highly remarkable that the solutions of maximum electric conductivity are also very nearly those in the formation of which nearly the maximum amount of heat is developed; this will at once be obvious on comparison of the curves given by Thomsen ("Thermochemische Untersuchungen," vol. iii.), and by Kohlrausch. In the chemist's experience, the point of maximum heat development is usually near to the point of maximum chemical change, and I think, therefore, that we are justified in concluding that, even if electrical conductivity be not a maximum at a particular concentration on account of the presence of a particular hydrate (belonging to the class of molecular aggregates) in maximum amount, at all events the "structure" of the system is especially favourable, and the "chemical influence" exerted by the one set of molecules upon the other is at a maximum at the point of maximum conductivity. The fact that the amount of sulphuric acid required to form a solution of maximum conductivity increases with temperature—

Temp.	0°	10°	20°	30°	40°	50°	60°	70°
Per cent	30.2	30.9	31.7	32.5	33.5	34.1	34.5	35.4

and also the fact that the maxima and minima of conductivity tend to become obliterated with rise of temperature (Kohlrausch), are both in accordance with the view that conductivity is in some way dependent upon chemical composition, as the effect of rise of temperature would be to cause the dissociation of hydrates such as I have referred to. The increase in conductivity of aqueous solutions with rise of temperature would appear to be against the view here put forward; but it is probable that this may be largely due to diminution in viscosity and increase in the rate of diffusion.

* Formula.	Formula weight.	P.c. in solution of max. cond.	Composition in approximate mol. ratios.	Conductivity.
HNO_3	63	29.7	1 : 8	7330
HCl	36.4	18.3	1 : 9	7174
H_2SO_4	98	30.4	1 : 12.4	6914
H_3PO_4	98	46.8	1 : 6	1962
$\text{C}_2\text{H}_4\text{O}_2$	60	16.6	1 : 17	15.2
KOH	56	28.1	1 : 8	5995
NaOH	40	15.2	1 : 12.7	3276

Our knowledge of the binary metallic compounds, which are generally admitted to be electrolytes *per se*, also affords evidence, I think, of an intimate relation between chemical constitution and "electrolysability." It has been pointed out (comp. L. Meyer, "Theorien d. mod. Chemie," 4th ed., p. 554) that, whereas all the metallic chlorides and analogous compounds which cannot be electrolysed are easily volatile bodies, the electrolysable metallic chlorides, &c., are fusible only at high temperatures. A careful discussion of the various known cases does not, however, justify the conclusion that decomposition takes place, or not, according as the temperature at which the body assumes the liquid state—and at which, therefore, there is full opportunity given for electrolysis to take place—is high or low, especially as recent observations show that electrolysis may take place prior to fusion. But it is especially noteworthy that many of the chlorides, &c. which are electrolytes undoubtedly contain more than a single atom of metal in their molecules; indeed, after careful consideration of the evidence, I am inclined to go so far as to put forward the hypothesis *that among metallic compounds only those are electrolytes which contain more than a single atom of metal in their molecules*. No difficulty will be felt in granting this of cuprous and stannous chlorides, and even of cadmium, lead, silver, and zinc chlorides; but opinions will differ as regards the metals of the alkalies and alkaline earths.* Assuming the constitution of metallic electrolytes to be such as I have suggested, it is not improbable that on electrolysis a part only of the metal is determined to the one pole, the remainder being transferred along with the negative radical to the opposite pole. Hittorf, indeed, has already put forward this view in explanation of the remarkable results he obtained on determining the extent of transfer of the ions in aqueous and alcoholic solutions of the chloride and iodide of cadmium and zinc.

Again, an argument in favour of a connexion between chemical constitution and electrical conductivity is the fact that carbon, sulphur, selenium, and phosphorus each exist in conducting and non-conducting modifications, as it can scarcely be doubted that the so-called allotropic modifications of these elements are differently constituted.

It appears, as I have already said, to be the current belief that when aqueous solutions are submitted to electrolysis, as a rule the dissolved substance, and not the water, is the actual electrolyte. Without reference to the question I have raised as to the constitution of an electrolyte, it appears at least doubtful whether this view can be justified by appeal to known facts; at all events, I have failed to find satisfactory evidence that such is the case. Moreover, as sulphuric anhydride dissolves in water with considerable development of heat, it would appear that more work has to be done to separate hydrogen from sulphuric acid than to separate it from water; on this account we might expect that the water rather than the acid would be decomposed. Are not perhaps both affected according to the proportions in which they are present? The marked variation in the extent to which the negative ion is transferred to the positive pole, as observed by Hittorf, when solutions of different degrees of concentration are electrolysed, would appear to support this view.

* We may regard as evidence in support of this explanation the fact that neither beryllium chloride, which fuses at 600°, nor mercuric chloride is an electrolyte, as both of these, at temperatures not far removed from their boiling-points, exhibit the simplest possible molecular composition. It should be pointed out, however, that Nilson and Patterson found it possible to determine the density of beryllium chloride gas at a temperature 100°–150° below the melting-point found by Carnelley; but they were not able to say that fusion took place. Clarke's recent interesting observations on mercuric chloride and iodide do not, I think, suffice to prove that these compounds are electrolytes; it is more than probable that electrolysis is preceded by the formation of mercurous compounds. Even an aqueous solution of mercuric chloride does not conduct appreciably better than water (Buff).

I should perhaps add that the mere presence of more than a single atom of metal in the molecule does not, I believe, also constitute the compound an electrolyte: much depends probably both on the nature of the metal and on the structure of the molecule.

The difference in the products, according as dilute or very concentrated solutions of sulphuric acid are used, may also be cited as an argument that the chemical changes effected vary with the concentration; but, on the other hand, it is quite possible that the observed differences may result from the occurrence of purely secondary changes. Ostwald has recently put forward the view that one *or more* of the hydrogen atoms of certain acids are split off according to the concentration of the solution.

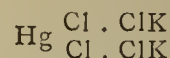
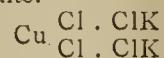
I call attention to this because I conceive that it has a most important bearing on the discussion of the nature of the chemical changes which occur during the dissolution of metals. Formerly it was said that when zinc acts upon dilute sulphuric acid, the zinc displaces the hydrogen of the water and the resulting zinc oxide dissolves in the acid, forming zinc sulphate; the modern explanation advocated by most chemists has been that the metal directly displaces the hydrogen of the acid: in fact, that this is the nature of the change whenever an acid is acted upon by a metal. If in a solution of sulphuric acid, of whatever strength, the acid be the actual electrolyte, I imagine that we are right in accepting this modern view; but if the water be the electrolyte, we must, to be consistent, return to the view that the oxide—more probably in most cases the hydroxide—is the primary product. And if it can be shown that during electrolysis both water and acid, according to circumstances—concentration, E.M.F., &c.—undergo change, it will be necessary to teach that in a similar manner the action of metals on acids is no less complex. Our views on the action of metals on concentrated sulphuric acid, and on solutions of nitric acid of various strength, must also materially depend on the interpretation of the behaviour of these acids on electrolysis with varying electromotive forces.

Having thus fully explained why I venture to think that Helmholtz's definition that "electrolytes belong to the class of typical compounds, not to that of molecular aggregates," is somewhat open to question, it now becomes necessary to make some slight reference to the constitution of these so-called molecular aggregates. Although opinions differ widely as to the definition to be given of a typical or atomic compound, and of a molecular compound or aggregate, the majority of chemists appear to agree that we must recognise the existence of two distinct classes of compounds. Professor Williamson, in his address to this Section at the York meeting (1881), entered at length into the discussion of this question, and in very forcible terms objected to the recognition of molecular combination as something different from atomic combinations; in this I, in the main, agree most fully with him. He further said that he had been led to doubt whether we have any grounds for assigning any limits whatever to atomic values, and he adduced a number of which, in his opinion, afforded illustration of a capability of elements to assume greater atomic values by combining with both negative and positive atoms than with atoms of one kind only; for example, he cited the compounds K_2CuCl_4 and K_2HgCl_4 as proof that copper and mercury may assume hexad functions; the compound K_2AgI_3 as an illustration that silver may act as a pentad; and the compounds $KAsF_6$ and K_2AsF_7 were regarded by him as evidence of the heptadicity and nonadicity of arsenic.

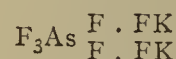
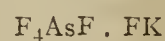
I have long been of opinion that the experimental investigation of this question is of great importance, and I believe that it must ere long attract the attention it deserves. The problem will be solved, not by discussions on the fertile theme of valency, but by determining the structure—the constitution—of bodies such as were referred to by Professor Williamson.

My own view on the question is a very decided one. So far as the mere definition of valency is concerned, I entirely agree with Lossen; and, as I have said, I hold with Prof. Williamson that in all compounds the constituents are held together by atomic affinities, and atomic

affinities only, but I believe that the formation of so-called molecular compounds is mainly due to peculiarities inherent more especially in the negative elements—*i.e.* the non-metals and metalloids, and not in the positive elements—the metals; in other words, to the fact, that as was first pointed out, I believe, by Lothar Meyer, the negative elements tend to exhibit a higher valency towards each other than towards positive elements. The view I take, then, is, that in the majority of so-called molecular compounds the parent molecules are preserved intact in the sense in which a hydrocarbon radical, such as ethyl, is preserved intact in an ethyl compound, being held together by the "surplus affinity" of the negative elements. Thus I would represent the compounds K_2CuCl_4 and K_2HgCl_4 as containing copper and mercury of the same valency as the metal in the parent chloride, and regard them as compounds of the radicals $(CuCl_2)$, $(HgCl_2)$, and (KCl) ; a view which may be expressed by the formulæ.



The arsenic compounds referred to may be similarly represented



We do not hesitate to attribute to the so-called double cyanides this order of structure, without in any way supposing that the metal changes in valency. Evidence that the "constituent radicals exist unchanged in molecular compounds" is afforded by facts such as that ferrous and potassium chlorides, for example, form a compound which obviously is still ferrous, being of a green colour, which would hardly be the case if the valency of the iron were increased; and that in like manner the compounds formed from stannous chloride manifest all the properties of stannous derivatives.

Whatever be the nature of chemical affinity, it is difficult to resist the conclusion that the "charge" of a negative radical especially is rarely, if ever, given up all at once, that its affinity is at once exhausted. It would also appear that the amount of residual charge—of surplus affinity—possessed by a radical after combination with others depends both on its own nature and that of the radical or radicals with which it becomes associated. Differences such as are observed in the composition and stability of the hydrates of the salts of an acid—the sulphates, for example—clearly point to this. Other illustrations are afforded by the manner in which chlorhydric acid yield chlorhydrates of some metals and chlorides of others.*

It is noteworthy, however, that often those elements which from the ordinary point of view are regarded as possessed of feeble affinities are those which manifest the greatest tendency to form molecular compounds. Thus, it is commonly held that, of the three elements, chlorine, bromine, and iodine, chlorine has the highest and iodine the lowest affinity, and this view accords well with the recent observations of V. Meyer on the relative stability of their diatomic molecules at high temperatures; but nevertheless we find that the compound which HI forms with PH_3 is far more stable than that of HBr or HCl with this gas; and it is well known that mercuric iodide has a much greater affinity for other iodides than have

* The name chlorhydric acid is here applied to the compound $HCl(OH_2)x$ —probably $x=1$ —which, according to Thomsen, is present in an aqueous solution of hydrogen chloride. It would be an advantage if we ceased to speak of HF , HCl , HBr , HI as acids, and always termed them hydrogen fluoride, chloride, bromide, and iodide, respectively. The names hydric chloride, bromide, &c., might with equal advantage be altogether abandoned; hydrochloric acid is objectionable, as suggesting a relation to chloric acid. The names fluor-, chlor-, brom-, and iodhydric, as applied to the acids present in aqueous solutions of the hydrides, are especially appropriate as indicating that they are compounds containing the radical water—that they are hydrates: indeed, it would be well to restrict the use of hydric and hydro- to bodies of this kind, and to speak of hydrides as hydri-, not as hydro-, derivatives. It would then be possible to give comparatively simple names even to complex hydrates.

mercuric bromide and chloride for the corresponding bromides and chlorides.*

The recognition of the peculiarity in the negative elements to which I would attribute the formation of molecular compounds must, I think, exercise an important influence in stimulating and directing the investigation of these compounds and of compounds other than those of carbon; in the near future the determination of the structure of such compounds should occupy an important share of the chemist's attention. It will perhaps afford a clue in not a few cases which are not altogether satisfactorily interpreted in accordance with the popular view of valency. I may instance the formation of (?) polymeric metaphosphates, of complex series of silicates and tungstates, and of compounds of hydrocarbons with trinitrophenol. It may even serve to explain some of the peculiarities of the more complex carbohydrates.

It is one of the most clearly established of the "laws of substitution" in carbon compounds that negative radicals tend to accumulate: numerous instances are afforded by the behaviour of paraffinoid compounds with chlorine, bromine, and oxidising agents, and by that of unsaturated paraffinoid compounds when combining with hydrogen bromide and iodide. The special affinity of negative elements for negative is not improbably the cause of this accumulation. A similar explanation may perhaps be given of some of the peculiarities which are manifested by benzenoid compounds.

I would even venture to suggest that in electrolysing solutions the friction arising from the attraction of the ions for each other is perhaps diminished, not by the mere mechanical interposition of the *neutral* molecules of the solvent—in the manner suggested by Kohlrausch—but by the actual attraction exercised by these molecules upon the negative ion in virtue of the affinities of the negative radicals.

One result of increased attention being paid to the investigation of problems such as I have indicated will probably be that we shall be called upon to abandon some even of our most cherished notions. I would suggest, for example, that it may become necessary to regard nitrogen peroxide not as a mixed anhydride of nitrous and nitric acids, but as a compound of two NO_2 groups; its conversion into nitrite and nitrate affords no proof of its constitution, as chlorine peroxide, ClO_2 , which exhibits no tendency whatever to combine with itself, also yields both chlorite and chlorate. A greater shock may result from a conviction arising that not only carbon dioxide, but sulphur dioxide, and perhaps even sulphur trioxide, dissolves in water, forming *hydrates*— $\text{SO}_2 \cdot \text{OH}_2$, $\text{SO}_3 \cdot \text{OH}_2$ —not *hydroxides*. In recent times, in discussing questions of this kind we have perhaps often been led to attach too much importance to the argument from analogy; it is not improbable that, especially in the case of compounds other than those of carbon, chemical change involves change in structure more frequently than we are apt to believe.

(To be continued.)

The Application of Elements, Oxides, Sulphides, and Oxy-Salts for the Transfer of Halogens.—C. Willgerodt.—Among the elements the best transferors of halogens are iodine and aluminium. Metallic iron and its oxides are well adapted for transferring chlorine and bromine; antimony, tin, and their oxides have been used with success. Bismuth, sulphur, arsenic, and amorphous phosphorus have far less transferring power.—*Journ. für Prakt. Chemie.*

* Thomson gives the values in heat units as—

$\text{HgCl}_2, 2\text{KClAq}$	= -1380
$\text{HgBr}_2, 2\text{KBrAq}$	= 1640
$\text{HgI}_2, 2\text{KI Aq}$	= 3450
$\text{HgCy}_2, 2\text{KCyaq}$	= 8830

UNIVERSITY COLLEGE, LONDON. ORGANIC CHEMISTRY.

DR. H. FORSTER MORLEY will give a Systematic Course of 80 Lectures on ORGANIC CHEMISTRY, beginning Wednesday, October 7th, at 9 a.m. First term: Elementary. Second term: Benzene Derivatives. Third term: Advanced. The course covers the subjects required for B.Sc. Fee, £2 12s. 6d. per term, or £6 6s. for the course.

TALFOURD ELY, M.A., Secretary.

UNIVERSITY COLLEGE, BRISTOL. CHEMICAL DEPARTMENT.

PROFESSOR—W. RAMSAY, Ph.D.

LECTURER—SYDNEY YOUNG, D.Sc.

The SESSION 1885-86 begins on 6th OCTOBER. Lectures on Inorganic, Organic, Advanced, and Technical Chemistry will be delivered during the Session. The Laboratories are fitted with the most recent improvements for the study of Practical Chemistry in all its branches. In the evening Lectures on Inorganic Chemistry at reduced fees are delivered; and a Special Course of Lectures on Technical Chemistry is also given, with the co-operation of the Worshipful Company of Clothworkers. A Correspondence Class especially adapted for those engaged in the Clothworking and Dyeing Industries will begin in October. Several Scholarships are tenable at the College. Calendar, containing full information, price 1s. (by post 1s. 3d.) For prospectus and further information apply to the Registrar.

CITY AND GUILDS OF LONDON INSTITUTE. TECHNICAL COLLEGE, FINSBURY.

AN OLD STUDENTS' DINNER will take place at the Manchester Hotel, Aldersgate Street, on Thursday, October 1st, at 6.45 p.m. Tickets, price 3s. 6d. (exclusive of wine), may now be obtained of A. C. F. WEBB (Sec. pro tem.), 53, Stanley Gardens, Belsize Park, N.W.

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GAS TAR.

The Directors of the Eastbourne Tar Company are prepared to receive tenders for the surplus tar made at their Works for one year from the 1st November next. The quantity made last year was about 120,000 gallons. The tar to be taken from the works in tanks to be provided by the Contractor, and at his own risk. Tenders to be endorsed "Tender for Tar," to be sent to the undersigned (at whose office a copy of the contract to be entered into may be seen) on or before the 2nd day of October next. The Directors do not bind themselves to accept the highest or any tender.

By order,

J. H. CAMPION COLES, Secretary.

Eastbourne, 8th September, 1885.

N.B.—There is a siding from the Railway Station to the Company's Works.

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TO TAR DISTILLERS, &c.

The Directors of the Sheffield United Gas

Light Company are prepared to receive TENDERS for the Purchase of the surplus TAR made at their Neepsend and Effingham Street Works for the period of 9 months from the 1st of October next. The quantities will be approximately: Neepsend, 5400 tons; Effingham Street, 1400 tons. At Neepsend the Tar will be loaded into tanks on the Company's siding, on the Manchester, Sheffield, and Lincolnshire Railway, or into barrel carts on the Works, and at Effingham Street into barrel carts only. Forms of Tender and conditions of contract may be obtained from the undersigned, to whom Tenders, endorsed "Tender for Tar," must be delivered on or before Saturday, September 19th.

The Directors do not bind themselves to accept the highest or any Tender.

HANBURY THOMAS, Manager.

Commercial St., Sheffield,
August 29, 1885.

TO CHEMICAL MANUFACTURERS.

To be Sold or Let, a newly-erected Works for the making of Aniline Oil and other Tar Products, and the distilling of Benzol. Also attached, a Coal Carbonising Works, with 3 acres of vacant land. All the Plant on the newest principle. Situated on the banks of a canal, 3 miles from Manchester.—Further particulars by applying to S. J., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E. C.

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W. FRESENIUS, Ph.D.;
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LECTURES.

Experimental Chemistry (Inorganic)	H. FRESENIUS, Ph.D.
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	E. BORGSMANN, Ph.D.
Chemistry and Analyses of Foods	W. FRESENIUS, Ph.D., and E. HINTZ, Ph.D.
Hygiene	Dr. med. F. HUEPPE.
Practical exercises in Bacteriology	
Technical Drawing, with exercises	F. BRAHM.

The next Session commences on the 15th of October. The Regulations of the Laboratory and the Syllabus of Lectures will be forwarded gratis on application to C. W. KREIDEL's Verlag, at Wiesbaden, or to the undersigned.

Prof. R. FRESENIUS, Ph.D.

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Office for the Examination of Provisions—Establishment for Experimental Chemistry and Bacteriological-Hygiene Institute—offers, in separate departments, best opportunity for a quick and sure improvement and accomplishment of practical savants for the examination of Provisions, Hygiene, Bacteriology, Mineral Chemistry, and Organic Chemical Work. Half-year's and Vacation Courses. (Admission of advanced Chemists, Apothecaries, and Physicians at any time.)—For all further particulars apply to Director Dr. SCHMITT.

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DEAN—Professor T. H. HUXLEY, P.R.S.

SESSION, 1885-86.

From the 1st October, 1885, till about the middle of June, 1886, the Laboratories will be open to Students in the following Sciences:—

CHEMISTRY AND AGRICULTURE.

PHYSICS.

BIOLOGY.

GEOLOGY.

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The following Courses of Lectures will be given during the Session:—Physics, Professor Guthrie, F.R.S. 1st Oct., 1885; Principles of Agriculture, J. Wrightson, Esq., 1st Oct.; Biology, G. B. Howes, Esq., 1st Oct.; Metallurgy, Professor Chandler Roberts, F.R.S., 2nd Oct.; Elementary Organic and Inorganic Chemistry, Professor T. E. Thorpe, F.R.S., 2nd Oct.; Mining, Professor Warington Smyth, F.R.S., 9th Nov.; Astronomical Physics, J. Norman Lockyer, Esq., F.R.S., 15th June, 1886; Elementary Geology, Professor Judd, F.R.S., 15th Feb.; Zoology and Palæontology, G. B. Howes, Esq., 15th Feb.; Botany, D. H. Scott, Esq., 15th Feb.; Advanced Organic and Inorganic Chemistry, Dr. F. R. Japp, F.R.S., F.C.S., 15th Feb.; Mineralogy, F. Rutley, Esq., 9th March.

A course of Mine Surveying, conducted by Mr. B. H. Brough, will begin on the 15th Feb., 1886.

In addition to the above, lectures will be given in the Chemical Department by Drs. Hodgkinson and Percy Frankland.

For further particulars apply to the Registrar, Normal School of Science, South Kensington.

THE LONDON HOSPITAL and MEDICAL
COLLEGE, MILE END, E.

The SESSION 1885-86 will COMMENCE on Thursday, October 1st, 1885. As the College will be in course of enlargement there will be no Public Distribution of Prizes this year. FOUR ENTRANCE SCHOLARSHIPS, value £60, £40, £30, and £20, will be offered for competition at the end of September to new students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free, and the holders of all the Resident appointments are provided with rooms and board entirely free of expense. The Resident appointments consist of Five House-Physicians, Five House-Surgeons, One Accoucheurship, and one Receiving Room Officer. Two Dressers and Two Maternity Pupils also reside in the Hospital. Special Classes for the Preliminary Scientific and Intermediate M.B. Examinations of the University of London, and for the Primary and Pass Examinations for the Fellowship of the Royal College of Surgeons of England, are held throughout the year. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis, and the Metropolitan, Metropolitan District, East London, and South Eastern Railways have stations within a minute's walk of the Hospital and College.

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An Examination for this Scholarship will be held early in October. Candidates must either have studied Chemistry two years in the College, or they may be B.Sc. of London, or Associates of the Institute of Chemistry. Application to be made before 1st October to

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THE CHEMICAL NEWS.

VOL. LII. No. 1347.

ADDRESS TO STUDENTS.

ONCE more the laboratories and lecture-rooms of our colleges are thrown open, and once more professors, demonstrators, and students are preparing to resume their duties. Once more also in accordance with our custom we take it upon ourselves to address a few hints to those who are beginning or continuing the study of chemistry, notwithstanding we have been told that, like the physician who when giving advice gratis to the poor prescribed a sojourn at Cannes or Madeira, we give recommendations inapplicable under the circumstances. We have always advised the student to qualify himself for original research, believing that such will prove the best course of training whether for pure chemistry or for its industrial applications. There are, however, two difficulties in the way. The first inheres in the progressive development of science. Research is like gold-finding. When a new auriferous region is first opened up the nuggets lie on or near the surface and may be secured with little preparation, skill, or effort. By degrees the placers are exhausted, and gold is obtained only by crushing quartz-reef and extracting the precious metal by processes which require ample capital, costly machinery, and technical skill. Just so it is or has been the case in chemical research. A century ago important facts as yet undetected lay, so to speak, on the surface, and might be stumbled upon by random experimentalists. Rough and simple apparatus was quite sufficient. In our days all this is changed. Truth lies now at the bottom of very deep wells. The problems to be grappled with, however numerous, are difficult and complicated, and require for their solution costly instruments of precision, an almost unlimited expenditure of time, and last, but chief of all, a thorough preparatory training, not merely in manipulation, but in the art of observation and in the right interpretation of the phenomena brought to light. Hence whosoever would be a discoverer must submit to a long and arduous course of preparation.

The second difficulty to be faced depends not on the stage which chemical science has reached, but upon mistaken arrangements. Let us suppose that a student has made a discovery of uncontested importance. Would it stand him any stead in the great task of passing his examinations? Would the examiners accept the fact of his having successfully conducted such an investigation as a proof that he must have a fair acquaintance with the principles of the science? Would they rather not say that his discoveries, important as they might be, were quite beside the question? Would not the young *savant* have simply to stand or fall by his more or less thorough acquaintance with "spread eagles?" We fear so: we do not know of one institution in Britain where successful research would be estimated at any number of "marks." In this country we prefer the man who can talk or write fluently on any subject, and who can reproduce such theories as happen to

be in vogue, to the man who can show, *rebus gestis*, that he is master of the subject.

From the pupil we turn to the master. There are, we are happy to say, many teachers of chemistry fully competent to train their students in research, and who would be delighted so to do. But they are prevented, substantially, just as if they were restrained by legal pains and penalties. For the reputation of a professor or teacher in England does not as in Germany depend on the quantity and quality of discoveries which issues from his school, but on the number of his disciples who "pass." If he falls short in this respect not merely his *kudos*, but something more tangible may in certain cases be imperilled. To expect a teacher so situate to train up discoverers is out of the question. Let him be ever so convinced of the superiority of original research over preparing for examinations, he can only say: *Video meliora proboque, deteriora sequor*.

UNIVERSITIES AND COLLEGES.

UNIVERSITY OF LONDON.

CANDIDATES for any Degree granted by this University are required to have passed the Matriculation Examination, to which no candidate is admitted unless he has produced a certificate showing that he has completed his sixteenth year.

The Fee for this examination is £2.

There are two Examinations for Matriculation in each year; one commencing on the second Monday in January, and the other on the third Monday in June. The Examination is conducted by means of Printed Papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the Candidates to pass, *viva voce* questions to any Candidate in the subjects in which they are appointed to examine.

Candidates are not approved by the Examiners unless they have shown a competent knowledge in each of the following subjects:—Latin. Any two of the following Languages:—Greek, French, German, and either Sanskrit or Arabic. The English Language, English History, and Modern Geography. Mathematics. Natural Philosophy. Chemistry.

The Examination in Chemistry is—Chemistry of the Non-metallic Elements; including their compounds—their chief physical and chemical characters—their preparation—and their characteristic tests.

A Pass Certificate, signed by the Registrar, will be delivered to each Candidate who applies for it, after the Report of the Examiners has been approved by the Senate.

If in the opinion of the Examiners any Candidates in the Honours Division of not more than Twenty years of age at the commencement of the Examination possess sufficient merit, the first among such Candidates will receive an Exhibition of thirty pounds per annum for the next two years; the second among such Candidates will receive an Exhibition of twenty pounds per annum for the next two years; and the third will receive an Exhibition of fifteen pounds per annum for the next two years; such exhibitions are payable in quarterly instalments, provided that on receiving each instalment the Exhibitioner declares his intention of presenting himself either at the two Examinations for B.A., or at the two Examinations for B.Sc., or at the Intermediate Examination in Laws, or at the Preliminary Scientific M.B. Examination, and Intermediate Examination in Medicine, within three academical years from the time of his passing the Matriculation Examination.

Under the same circumstances, the fourth among such Candidates will receive a prize to the value of ten

pounds in books, philosophical instruments, or money; and the fifth and sixth will each receive a prize to the value of five pounds in books, philosophical instruments, or money.

Any Candidate who may obtain a place in the Honours Division at the Matriculation Examination in January is admissible to the Intermediate Examination either in Arts or in Science in the following July.

INTERMEDIATE EXAMINATION IN SCIENCE.

The Intermediate Examination in Science will be held in July, 1886.

No Candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

Candidates will be examined as follows:—For a Pass or for Honours in (1) Inorganic Chemistry, (2) Experimental Physics, (3) Mathematics; and for a Pass only in (4) General Biology. Candidates may also be examined for Honours in Botany and in Zoology.

Every Candidate, on sending in his name for the Examination, must state whether he intends to compete for Honours in any subject or subjects; and if he does so intend, must specify the subject or subjects.

No Candidate will be allowed to take both the Pass and the Honours Papers in the same subject, but every Candidate must take the Pass Papers in those subjects in which he does not offer himself for Honours.

A Candidate who enters for, but fails to obtain, Honours in Inorganic Chemistry, Experimental Physics, and Mathematics, may be recommended by the Examiners for a Pass in these subjects respectively, if they are satisfied that he has shown such a competent knowledge thereof as is required by the Regulations for the Pass Examination.

The Examiners will make no report upon the Examination for Honours of a Candidate who has failed in any part of his Pass Examination.

Examination for Honours.

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition, they will be examined practically in Simple Qualitative Analysis. This Examination, will consist of six hours' examination by two printed papers and of six hours' practical work.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself will receive an Exhibition of £40 per annum for the next two years.

B.Sc. EXAMINATION.

The B.Sc. Examination will be held in October.

Candidates for this Examination are required to have passed the Intermediate Examination in Science at least one academical year previously.

The Fee for this Examination is £5.

The regulations are framed with the view of allowing the candidate to select any three of the following nine subjects:—

1. Pure Mathematics.
2. Mixed Mathematics.
3. Experimental Physics.
4. Chemistry.
5. Botany, including Vegetable Physiology.
6. Zoology.
7. Animal Physiology.
8. Physical Geography and Geology.
9. Mental and Moral Science.

Examination for Honours.

The examination for Honours in Chemistry will take place on Monday and Tuesday in the week following the Examination for Honours in Mathematics; on Monday by printed papers (chiefly on Organic Chemistry), and on

Tuesday by practical exercises in Simple Qualitative and Quantitative Analysis.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

DOCTOR OF SCIENCE.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University.

The Fee for this Examination is £10.

Every Candidate for the degree of D.Sc. must forward a statement in writing of the special subject within the purview of the Faculty of Science, as set out in the programme of the B.Sc. Examination, upon a knowledge which he rests his qualification for the Doctorate; and with this statement he shall transmit an original printed Dissertation or Thesis (at least six copies) treating scientifically some special department of the subject so named, embodying the result of independent research, or showing evidence of his own work, whether based on the discovery of new facts observed by himself, or of new relations of facts observed by others, or, generally, tending to the advancement of Science. The Dissertation or Thesis shall have been written in view of candidature, or shall have been published within the two academical years immediately preceding. Every candidate may further specify any printed contribution or contributions to the advancement of Science which he has at any time previously published, and every contribution so specified and submitted shall be considered and taken as part of his qualification for the degree. Candidates for the degree of D.Sc. will be expected to be so fully conversant with the branch of Science they profess as to be able, if required, to satisfy any test of their acquirements in that branch that it may be thought expedient to apply.

PRELIMINARY SCIENTIFIC (M.B.) EXAMINATION.*

This Examination shall take place twice in each year,—once, for Pass and Honours, commencing on the third Monday in July; and once for Pass Candidates only, commencing on the third Monday in January.

No Candidate shall be admitted to this Examination unless he shall have passed the Matriculation Examination, nor unless he have given notice of his intention to the Registrar at least one calendar month before the commencement of the examination.

The Fee for this examination shall be Five Pounds.

Candidates for the Pass Examination, whether in January or July, will be allowed either to take all the three subjects of the Examination—(a) Inorganic Chemistry, (b) Experimental Physics, and (c) General Biology—at the same Examination, or to take them at two separate Examinations,—that is to say, two subjects at the first Examination for which they may enter, and one subject at the second Examination; or, reversely, one subject at the first Examination, and two at the second.

Candidates at the July Examination who enter for the whole Examination shall be examined as follows:—For a Pass or for Honours in (a) Inorganic Chemistry, (b) Experimental Physics; and for a Pass in (c) General Biology. Candidates who have entered for the whole Examination may also be examined for Honours in Botany and in Zoology.

Every Candidate, on sending in his name for the July Examination, must state whether he intends to compete

* Candidates who pass in all the subjects of the Preliminary Scientific (M.B.) Examination, and also pass at the same time in the Pure and Mixed Mathematics of the Intermediate Examination in Science, or who have previously passed the Intermediate Examination in Arts, are admissible to the B.Sc. Examination.—No additional fee is charged for admission to the Examination in Mathematics.

for Honours in any subject or subjects; and, if he does so intend, must specify the subject or subjects.

No Candidate will be allowed to take both the Pass and the Honours Papers in the same subject; but every Candidate must take the Pass Papers in those subjects in which he does not offer himself for Honours.

A Candidate who enters for, but fails to obtain, Honours in Organic Chemistry or Experimental Physics may be recommended by the examiners for a Pass in these subjects respectively, if they are satisfied that he has shown such a competent knowledge thereof as is required by the Regulations for the Pass Examination.

EXAMINATION IN SUBJECTS RELATING TO PUBLIC HEALTH.

A Special Examination will be held in December in subjects relating to public health.

No candidate is admitted to this Examination unless he has passed the Second Examination for the Degree of Bachelor of Medicine in this University at least one year previously; nor unless he shall have given notice of his intention to the Registrar at least two calendar months before the commencement of the Examination.

The Fee for this Examination is £5.

UNIVERSITY OF OXFORD.

Waynflete Professor of Chemistry.—W. Odling, M.A., F.R.S.

Professor of Mineralogy.—N. S. Maskelyne, M.A., F.R.S.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years, passing at least two examinations in Arts, and one in either Mathematics, Natural Science, Law, Modern History, or Theology, when, if he obtain a first, second, or third class, he can take his B.A. Degree; if he do not gain such honour he has to pass a third examination in *Literis Humanioribus*.

The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other colleges, by competitive examination in Natural Science.

More detailed information may be obtained from the University Calendar; from the professors; from E. Chapman, Esq., M.A., Frewin Hall; and from the Sub-Librarian in the Radcliffe Library or the Museum.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A., F.R.S.

Jacksonian Professor of Natural and Experimental Philosophy.—J. Dewar, M.A., F.R.S.

The Student must enter at one of the Colleges, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in the first or second term of residence, or, through the Oxford and Cambridge Schools Examination Board, or through the Senior Local Examinations, before commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

The scholarships, ranging in value from £20 to £80 a year, are chiefly given for mathematical and classical proficiency. Scholarships are given for Natural Science in Trinity, St. John's, St. Peter's, Clare, Christ's, Sidney, Pembroke, Caius, and Downing Colleges; the examinations being at Easter, and in June and October.

The Chemical Laboratory of the University is open daily for the use of the Students. The Demonstrators attend daily to give instructions.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the

other Students. They are under the superintendence of the Rev. R. B. Somerset, Orford House, Cambridge, from whom further information may be obtained.

The following are the Lectures on Chemistry for the ensuing Academical Year:—

MICHAELMAS TERM, 1885.

General Course, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Oct. 13.

Dissociation and Thermal Chemistry (Advanced), by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Oct. 14.

Thermo Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 13.

General Principles (elementary) by Mr. Pattison Muir, Caius College, Monday, Wednesday, and Friday, at 10 a.m. Begin Oct. 14.

Chemistry of Carbon Compounds, by Mr. Pattison Muir, Caius College, Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 15.

Elementary Organic Chemistry, by the Assistant to the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 1 p.m. Begin Oct. 14.

General Principles (Non-metals) for Natural Science Tripos, by Mr. Heycock, at King's College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Oct. 14.

Organic Chemistry, by Mr. R. M. Lewis, at Downing College, on Tuesdays, Thursdays, and Saturdays, at 9 a.m. Begin Oct. 13.

Practical Chemistry, by the Demonstrators of Chemistry. University Laboratory. Also at St. John's, Caius, and Sidney Colleges. Daily. Begin Oct. 13.

LENT TERM, 1886.

General Course continued, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Jan. 19.

Organic Chemistry, by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Jan. 20.

General Course of Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Jan. 19.

General Principles (continued) by Mr. Pattison Muir, at Caius College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Jan. 19.

Chemistry of Carbon Compounds (advanced), by Mr. Pattison Muir, Caius College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Jan. 20.

Methods of Organic Analysis, by the Assistant to the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 1 p.m. Begin Jan. 20.

Chemical Philosophy, by Mr. Heycock, King's College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Jan. 18.

Practical Chemistry, at the University Laboratory, and at St. John's, Caius, and Sidney Colleges, daily. Begin Jan. 18.

EASTER TERM, 1886.

Elementary Chemistry, by a Demonstrator, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin April 30.

General Course continued, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 10. Begin April 29.

Elementary Course for first M.B. (continued), including Carbon Compounds, by Mr. Pattison Muir, at Caius Laboratory, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin April 29.

Gas Analysis, by the Assistant to the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin April 30.

Practical Chemistry, at the University Laboratory, at St. John's College, at Caius College, and at Sidney College, daily. Begin April 29.

KING'S COLLEGE.

(DEPARTMENT OF ENGINEERING AND APPLIED SCIENCE.)

Professor of Chemistry.—C. L. Bloxam, F.C.S.*Demonstrator of Practical Chemistry.*—J. M. Thomson, F.C.S.*Assistant Demonstrator.*—G. S. Johnson, F.C.S.*Chemical Tutor.*—Herbert Jackson, F.C.S.

On Tuesday and Friday at 10.20 a.m. Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a View of the Forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic elements and their principal Compounds are described.

The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures, of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examinations of the Class, both *vivâ voce* and by written papers, are held at intervals during the course at the usual Lecture hour.

Second Year.—Students attend in the Laboratory twice a week, on Tuesday and Friday, at 10.20, and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this Department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra Fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own Experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry per term, £3 3s. od.; per ann., £8 8s. od.; Practical Chemistry per term, £4 4s. od.; per ann., £10 10s. od.; Experimental and Analytical Chemistry—One Month (daily attendance), £4 4s. od.; Three Months (daily attendance), £10 10s. od.; Six Months (daily attendance), £18 18s. od.; Nine Months (daily attendance), £26 5s. od. A student taking a month's ticket may attend daily during 1 month, or 3 days a week during 2 months, or 2 days a week during 3 months.

Rules as to Admission of Students.

I. The Academical Year consists of Three terms: Michaelmas Term, from beginning of October to the week before Christmas; Lent Term, from the middle of January to the week before Easter; Easter Term, from Easter to the beginning of July.

II. The days fixed for the Admission of New Students in the Academical Year 1885-86, are Tuesday, September 29, Tuesday, January 19, and Tuesday, May 4.

METALLURGY.

Professor.—A. K. Huntington, F.I.C., F.C.S., &c.*Demonstrator.*—W. G. McMillan.

The following subjects are treated of in the Lectures: The Selection and Economic Preparation of Fuel and of Refractory Materials; the methods by which metals are obtained from their ores, and the means by which they are rendered suitable for the various requirements of the Arts,

Particular attention is made to the study of the Nature and Properties of Metals and Alloys available for Constructive Purposes.

In the Metallurgical Laboratory, which is always open during College hours, the relation between the Chemical Composition of Metals and their Mechanical Properties may be studied by the aid of Testing Machinery. The instruction given to each student is regulated by his special requirements.

Fees:—Lectures only, £3 3s. The laboratory fees are arranged for continuous work and intermittent work, and special arrangements as to attendance may be made with the Professor.

Two courses of lectures will be delivered on Monday evenings, in which especial attention will be devoted to the requirements for the examination of the City and Guilds of London Institute. A Practical Metallurgical Class will be held on Friday evenings, at which students may prepare for the examination of the Science and Art Department in Practical Metallurgy.

EVENING CLASSES.

Classes for Evening Instruction in various subjects are held during the months from October to March, inclusive, and during the months of April, May, and June. The next Winter Course will begin on Monday, October 5th, and will terminate on Friday, April 2nd, 1886, the last fortnight being devoted to examinations. Many of these classes have special reference to the B.A. and Matriculation Examinations of the University of London.

Agriculture.—A Course of Lectures on this subject will be given during the ensuing Winter by Mr. Frederick James Lloyd, F.C.S., of the Royal Agricultural Society of England. The Lectures will be given on Monday Evenings at 8 p.m., beginning October 5th, 1885.

UNIVERSITY COLLEGE.

FACULTY OF SCIENCE.

Professor.—Alex. W. Williamson, Ph.D., LL.D., F.R.S.*Lecturers.*—Henry Forster Morley, M.A., D.Sc.; R. T. Plimpton, Ph.D.

The Session is divided into three Terms, as follows, all the dates being inclusive:—

First Term, from Monday, October 5th, until Saturday, December 19th;

Second Term, from Wednesday, January 6th, 1886, till Saturday, March 20th;

Third Term, for Lectures, from Tuesday, March 23rd, till Wednesday, June 16th. Class Examinations occupy about ten days, beginning on Thursday, June 17th.

Students, who having entered in October do not intend to present themselves in all three subjects at the July Preliminary Science Examination, should during the first term confine their attention to Chemistry, and take this subject alone at the January Examination.

Students entering in January should take Physics and Biology at the July Examination, and Chemistry at the succeeding January Examination.

The Special Course on the Metals will be given by Mr. Rideal on Monday, Wednesday, and Friday, at 10.

Introductory or Matriculation Course.

Tuesday, Wednesday, and Friday, at 11, commencing May 4, 1886. Fee:—£4 4s.

The Course will consist of about thirty lessons, partly theoretical and partly practical, on the non-metallic elements. Frequent exercises will be given.

General Course of Chemistry and Chemical Physics.

First and Second Terms: Inorganic.—The Class meets five times a week: Mondays, Wednesdays, and Fridays, at 11, for Lectures or Examinations; and on Tuesdays and Thursdays, at 9, for Exercises.

Third Term: Elementary Organic.—Lectures or Exercises, Tuesdays, Wednesdays, and Fridays, at 11.

Fee:—For the Course, £7 7s.; Perpetual, £9 9s.; for

the First or Second Terms, £3 3s.; for the Third Term, £3 3s.

The subjects treated in the First Terms of the Course include those required in Chemistry at the Matriculation Examination of the University of London.

For the Preliminary Scientific Examination Students who take the three subjects for that examination in July attend during the First and Second Terms.

Extra Meetings of the Exercise Class in connection with the General Course will be held in the Third Term for those Students who intend to present themselves for the Preliminary Scientific or Intermediate Science Examination in July.

The Third Term provides instruction in the preparation, composition, and fundamental properties of the most common important organic substances. The subjects dealt with include those required by Candidates for the First Examination under the conjoint scheme. The last three Meetings will be devoted to recapitulation.

Advanced Course of Inorganic Chemistry.

Third Term:—Monday, Wednesday, and Friday at 4.

Fee:—£2 2s.

The Course will consist of about Thirty Lectures, and is intended as a supplement to the General Course. It includes the subjects required for the Honours Papers in the Preliminary Scientific and Intermediate B.Sc. Examinations and the Additional Inorganic Chemistry for the B.Sc.

Organic Chemistry.

Monday, Wednesday, and Friday, at 9, in the First and Second Terms; and Tuesday and Thursday, at 9, in the Third Term, beginning Wednesday, October 7th. The hour of meeting will be altered should the Class desire it.

This Course of Organic Chemistry is intended for those who in studying the subject have not a Medical Examination chiefly in view. Candidates for Honours at the Int.M.B. are, however, recommended to attend this Course during the First and Second Terms, instead of the Special Summer Course.

The Course includes the subjects required at the B.Sc. Examination, Pass and Honours; but no previous acquaintance with Organic Chemistry will be expected of those joining the Class.

Fee:—For the Course, £6 6s.; for a Term, £2 12s. 6d.

Practical Class.

First and Second Terms, on Tuesday and Thursday, at 11 or 10. Each Student will attend twice a week, at the hour allotted to him, on arrangement with the Professor.

Fee, including cost of materials, £5 5s.; for a Second Course, £3 3s.

The Course includes the Practical Chemistry required at the Preliminary Scientific, Intermediate B.Sc., and Conjoint Scheme Examinations.

Senior Practical Class.

Mondays and Saturdays from 10 to 12 during the Third Term.

Fee:—(Including cost of materials) £5 5s.; for a Second Course, £3 3s.

Matriculation Course. (Women.)

Lectures: Wednesday and Friday, from 4 to 5.

A Class of Elementary Chemistry, including the subjects required for Matriculation, will be given during the Second and Third Terms, commencing Wednesday, January 7th.

Fee:—For the Course, including the cost of apparatus and materials, £4 4s.

Inorganic Chemistry. (Women.)

Lectures and Practical Work: Tuesday, Wednesday, Thursday, and Friday at 2, during the First and Second Terms, beginning on Wednesday, October 7th. The time of meeting will be altered to suit the convenience of the Class.

This Class includes the subjects required for the Pre-

liminary Scientific and Intermediate B.Sc. Examinations. An elementary knowledge of Chemistry will be expected from Students joining the class. Simple Qualitative Analysis will be practised by the Students.

Fee, including cost of apparatus and materials, £7 7s.

Quantitative Analysis.

A Course of Ten Lectures on the newer methods of Quantitative Analysis will be given during the Second Term, on Mondays, at 4. Fee, £1 1s. Some of the more important operations and methods of Quantitative Analysis will be described, including some of the best methods which are of too recent introduction to have found a place in the ordinary text-books.

Analytical and Practical Chemistry.

The Laboratory is open daily from 9 a.m. to 4 p.m., Saturdays, 9 a.m. to 2 p.m., from October until the middle of July, with a short recess at Christmas and at Easter.

Fees: for the Session, £26 5s.; six months, £18 18s.; three months, £10 10s.; one month, £4 4s.

Three specified days a week:—for the Session, £15 15s.; six months, £11 11s.; three months, £6 6s.; one month, £2 12s. 6d., exclusive of expense of materials. Students may enter at any period of the Session.

The Laboratory Course includes the Practical Chemistry required at the following Examinations of the University of London:—Prel. Sci. (M.B.), Intermediate M.B., Intermediate B.Sc., B.Sc., D.Sc.

Students who wish to attend the Laboratory and Classes of Technical Chemistry may acquire here the requisite preliminary knowledge of Practical Chemistry and Analysis.

When accompanied by, or preceded by, attendance on the Lectures on Chemistry and Organic Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to Manufactures, Metallurgy, Medicine, or Agriculture, &c.

There is also a Chemical Library containing the chief Journals and Standard Works on Chemistry.

A Gold Medal and Certificates of Honour are competed for by Students entered for the Session.

Chemical Technology.

Professor CHARLES GRAHAM, D.Sc., F.I.C.

Assistants.—C. J. Wilson, F.C.S., and W. J. Scrutton.

The Course of instruction in this Department is designed to afford to Students who propose to devote themselves to industrial pursuits in which Chemistry plays an important part, or to prepare themselves for the profession of Consulting Chemist, the instruction essential for their success in their future line of work. It will also be found of great value in two of the branches (Organic and Inorganic Chemistry) in which the Degree of Doctor of Science can be taken at the University of London.

In the Session 1885-86, it is proposed to treat of the following subjects:—

Heating and Lighting.

Metallurgy.

The Chemistry of the Alkali trade.

Chemistry of Brewing.

Agricultural Chemistry.

Fees—for each Course, £2 2s.; for two Courses, £3 3s.; for the five Courses, £5 5s.

Laboratory of Chemical Technology.

The instruction in the Laboratory of Chemical Technology will consist of the examination and valuation of raw materials used, and of the final products obtained in various manufacturing industries, and of experimental examination of the processes employed in the arts and manufactures.

The Laboratories are open daily from 9 a.m. to 4 p.m., from the 6th of October until the middle of July, with a short recess at Christmas and at Easter.

Fees—for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

NORMAL SCHOOL OF SCIENCE AND
ROYAL SCHOOL OF MINES.*Professor.*—T. E. Thorpe, Ph.D., B.Sc., F.R.S.*Assistant Professor.*—F. R. Japp, M.A., Ph.D., F.R.S.*Demonstrators.*—W. R. Hodgkinson, Ph.D., and P. F. Frankland, Ph.D., B.Sc.*Assistants.*—G. S. Newth and H. Chapman Jones.

The Normal School of Science at South Kensington is intended, primarily, for the instruction of teachers, and of students of the industrial classes selected by competition in the examinations of the Science and Art Department. The Royal School of Mines is affiliated to the Normal School. Students entering for the Associateship of the School of Mines obtain their general scientific training in the Normal School. The instruction in the Normal School is arranged in such a manner as to give the Students a thorough training in the general principles of Science, followed by advanced instruction in one or more special branches of Science. The Associateship is granted in certain divisions or lines of study. Students who go through any one of the prescribed courses of instruction and pass the necessary Examinations receive a Certificate of Associateship of the Normal School, or of the Royal School of Mines. But students who are not candidates for the Associateship are permitted to take up the course of instruction in one or more special branches of science, and on passing the examination receive a Certificate to that effect. The Associateship of the Normal School of Science is given in one or more of the following divisions:—Mechanics, Physics, Chemistry, Biology, Geology, and Agriculture, and the Associateship of the Royal School of Mines in Metallurgy and Mining.

The course of instruction is the same for all the divisions during the first two years, after which it is specialised in accordance with the Scheme detailed in the Prospectus of the School.

The Session is divided into two Terms. The first Term begins about the 1st of October and ends about the middle of February. The second Term begins in the middle of February and ends about the middle of June.

Examinations are held at the end of each course of instruction and at such other periods as may be found necessary. On the results of these examinations the successful candidates are arranged in two classes, first and second. There are also "Honours" examinations for the subjects of the third and fourth years, the successful candidates being placed in order of merit. A student obtains the Associateship who passes in all the subjects of the first two years and of the special division he selects for his Associateship. A student who goes through the prescribed course of instruction in any subject and passes the final examination in it receives a certificate to that effect.

Students who do not wish to attend the lectures are admitted for short periods to the laboratories, at the discretion of the Professors. The fees for the laboratories are £4 per month.

Admission is granted to persons desirous of attending certain courses of the lectures without the laboratory instruction, on payment of the lecture fees.

The fees which are shown in the following table must be paid to the Registrar of the School before the commencement of each course.

	Part I.	Part II.	Part III.	Part IV.
	Lecs.	Lab.	Lecs. & Lab.	Lecs. & Lab.
Chemistry	£ 4	£ 13	£ 15	£ 15
Physics	5	12	12	12
Biology with Botany	5	12	12	12
Geology with Mineralogy	4	8	8	
Mechanics	4	6	8	8
Metallurgy	2	13	15	
Mining	4	6		
Agriculture	4	10		
Astronomy	2			

Mathematics and Mechanical Drawing £3 per term. Geometrical Drawing, £3 per session. Freehand Drawing, £1 per term.

Thus the fees for the first two years amount to about £75, and for the remainder of the course for the Associateship they vary from £30 to about £40.

Both the private and the State-aided students are required to furnish themselves with certain instruments and apparatus before the commencement of the courses. These are enumerated in the syllabuses of the several subjects.

Officers of the Army, Navy, and Civil Service, recommended by their respective Departments, are admitted to the Lectures and Laboratories at half the foregoing charges.

Associates of the Normal School of Science or of the Royal School of Mines have the privilege of free admission to the Library and to all the courses of lectures.

Science teachers actually engaged in teaching who are registered by the Science and Art Department as qualified to earn payments for teaching Science may attend any course of lectures on the payment of £1.

Several valuable Exhibitions, Scholarships, and Prizes are attached to the studentship.

Summer Courses for Teachers.—Short courses of instruction are given annually, about July, in different branches of science for the benefit of teachers of science schools in the country. The courses last three weeks. About 200 teachers are admitted to them, and they receive 2nd class railway fare to and from South Kensington, and a bonus towards their incidental expenses of £2 each. (See Science Directory.)

Working Men's Lectures.—Three courses of evening lectures for working men will be given during the session in Biology, Mining, and Astronomical Physics. The admission to each course of six lectures will be 6d. The number of tickets is limited by the size of the lecture theatre.

UNIVERSITY COLLEGE OF WALES,
ABERYSTWYTH.

Professor of Chemistry and Experimental Physics.—T. S. Humpidge, Ph.D., B.Sc. (Lond.)

The College is open to male and female students not under the age of 15 years.

The Courses will be as follows.—I. Introductory and Chemistry of the Non-Metals, during Christmas Term. II. Chemistry of the Metals and Chemical Theory, during Lent Term. III. Organic Chemistry and Advanced Theoretical Chemistry, during Easter Term.

Course I. will suffice for the requirements of the London University Matriculation and other similar examinations. Candidates for the Intermediate B.Sc. and Preliminary Scientific (M.B.) Examinations will require Course II. as well, and must also take a course of practical instruction in the Chemical Laboratory. Course III. will meet the requirements of Students taking Chemistry in the B.Sc. and other advanced examinations.

In connection with Courses I. and II. there will be Exercise Classes meeting once a week.

The Lectures will be delivered and the Exercise Classes will meet on Tuesdays, Wednesdays, Thursdays, and Fridays at 9 a.m.

Practical Chemistry.—The Laboratory is open to Students daily during the Session from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except Saturdays.

Special courses will be arranged for those Students who intend following Medicine, Pharmacy, Agriculture, Applied Chemistry, or other professions in which a knowledge of technical chemistry is required.

The Fee for the whole Session, paid in advance, is £10; if paid by single Terms, for the first Term of attendance in each Session £4; for the second Term, £3 10s.; for the third Term £3. The Fee for Practical Chemistry, or Practical Physics, is 5s. per Term extra. Any person

wishing to attend single classes may do so on payment of the sum of £1 per Term for each class.

Several valuable Scholarships and Exhibitions are attached to the Studentship.

Fee for all subjects extending over the whole Session, £10. Practical Chemistry, 5s. per term extra.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE.

Professor.—C. M. Thompson, M.A., D.Sc.

Demonstrator.—J. W. James, Ph.D., F.C.S.

The Session commences in October and terminates in June, and is divided into three terms.

The Junior Course (during the summer term only) will cover the subjects prescribed for the London University Matriculation examination. Fee, £2 2s.

The Intermediate Course, together with laboratory practice, will cover the subjects required for the Intermediate Examination in Science and the Prel. Sci. (M.B.) Examination of the University of London. It will also be adapted for those students who, having the elementary knowledge which might be gained in the Junior Course, wish to obtain a more extended knowledge with a view to its application in the Arts. Fee, £3 3s.

The Senior Course will occupy about two terms. Fee, £3 3s.

Evening Lectures.—Courses of Lectures will be given on Elementary Chemistry by Prof. Thompson, and on Metallurgy by Dr. James.

At the entrance examination in September, and the annual examination in June, several scholarships, &c., are awarded.

UNIVERSITY COLLEGE, BRISTOL.

Professor of Chemistry.—W. Ramsay, Ph.D.

Lecturer.—Sydney Young, B.Sc.

DAY LECTURES.

Inorganic Chemistry.

Junior, Senior, and Advanced Classes.

The Course treats of the principles of Chemistry, and of the Chemistry of the Non-Metals and Metals.

Lectures will be given daily at 9 o'clock.

Organic Chemistry.

This Course will relate to the more important groups of the Compounds of Carbon.

Lectures will be given during the Second Term on Tuesdays and Thursdays at 10 o'clock; during the Third Term on Tuesdays, Thursdays, and Saturdays at 10 o'clock.

Fee, £3 3s.

Practical Chemistry.—Laboratory Instruction.

The Laboratory will be open daily from 10 a.m. to 5 p.m., except on Saturdays, when it will close at 1 p.m. Instruction will be given in the Laboratory in all branches of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures, and to Scouring, Bleaching, and Dyeing. The Laboratory is under the immediate supervision of the Professor and the Lecturer.

Fees in Guineas—

	6 Days a Week.	5 Days a Week.	4 Days a Week.	3 Days a Week.	2 Days a Week.
Per Session ..	17	15	13	10	7½
„ Two Terms ..	13	11	9	7½	5½
„ One Term ..	7	6	5	4	3
„ Month ..	3	3	2	2	1½

Students may arrange to divide their days of laboratory work into half-days.

In order that Students may have an opportunity of acquiring some knowledge of Applied Chemistry, excursions to some of the Mines and Manufactories of the neighbourhood will be occasionally made. They will be conducted by the Professor or by the Lecturer.

Correspondence Classes are held for the purpose of giving instruction in chemical processes important to those engaged in the manufacture of woollen goods.

EVENING LECTURES.

Lecturer.—Sydney Young, B.Sc.

Wednesday and Friday, 8 to 9.

This course will consist of Two Lectures a week during the First and Second Terms; they will be devoted to the consideration of the general Principles of Chemistry and Chemical Physics and the Chemistry of Non-Metallic Elements. Special attention will be paid throughout to those products which have a practical application in the Arts and Manufactures.

Fee, 15s. for Two Terms; 10s. for One Term.

Technical Chemistry.—Special Courses.

Professor.—W. Ramsay, Ph.D.

A Course of Lectures will be delivered on Tuesday evenings at 8 o'clock, during the first term, on the Scouring, Bleaching, and Dyeing of Wool, Silk, Cotton, Linen, and Jute. This course is designed to afford information to those engaged in the manufacture and sale of articles made of the above materials. It will imply no previous knowledge of chemistry; but those who purpose to attend it are recommended to enter the Evening Chemistry Classes during the first Term.

Fee for the Course, 10s.

A Course of Lectures will be delivered on Tuesday evenings at 8 o'clock, during the second term, on Fuel, and on the Metallurgy of Iron and Steel. Fee for the Course, 10s.

Chemical Scholarship.—Among others, a Chemical Scholarship of £25 is offered for competition.

With the approval of the Council of the Institute of Chemistry students desiring to qualify as Associates may pass through the requisite amount of study at this College, which has also been approved as a centre for the Practical Examination of the Institute.

MASON SCIENCE COLLEGE, BIRMINGHAM.

Professor.—W. A. Tilden, D.Sc., Lond., F.R.S.

Assistant Lecturer.—W. W. J. Nicol, M.A., D.Sc., Edin.

Demonstrator.—Thomas Turner, F.C.S.

The Session will be opened on Thursday, October 1st, 1885.

Elementary Course.

Twenty Elementary Lectures adapted to the requirements of beginners will be given in the Winter Term, and will be repeated after Christmas, on Mondays and Fridays at 12.30. The Second Course will begin on the first Monday in March.

Persons entirely unacquainted with Chemistry are recommended to attend these Lectures before entering for the General Course, which commences in October. Candidates for the Matriculation Examination of the University of London may obtain the instruction they require for that Examination by attending this Course.

General Course.

The General Course of Lectures on Chemistry will be found useful by Students who are afterwards to become Engineers, Architects, Builders, Brewers, or Manufacturers (such as Metallurgists, Alkali, Soap, Manure, Glass, or Cement Makers, Bleachers and Dyers, &c.)

Students preparing for the Intermediate Examination in Science and Preliminary Scientific (M.B.) Examination of the University of London, should attend the Lectures on *Inorganic Chemistry* (Winter and Spring Terms).

Candidates for B.Sc. and Intermediate Examinations in Medicine will in general require only that part of the course (Summer Term) which relates to *Organic Chemistry*.

The full course, extending over three terms, will also satisfy the requirements of Students preparing for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

1. From October to March (Winter and Spring Terms). About one hundred lectures on *Inorganic Chemistry and Chemical Philosophy* will be given on Mondays, Tuesdays, Wednesdays, Thursdays, and Fridays, at 9.30 a.m. Fee, £3 3s. for a single term, or £5 5s. for the course from October to March.

2. April to June (Summer Term). About forty lectures will be given on *Organic Chemistry*, or the chemistry of the most important series of carbon compounds. This course will include all the subjects required for the Intermediate Examination in Medicine of the University of London. Lecture Days.—Monday, Tuesday, Wednesday, and Thursday, at 9.30 a.m. Fee, £2 2s.

In both these courses the instruction at least once a week will take the form of class teaching, and exercises will be set which students will be expected to work at home.

Laboratory Practice.

The College Laboratory will be open daily from 9.30 to 5, except on Saturdays, when it will be closed at 1 p.m.

Candidates for Intermediate Examination in Science, Preliminary Scientific (M.B.), B.Sc., and Intermediate Examination in Medicine of the University of London, may obtain in the Laboratory of the College the instruction necessary. The three months Course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health may be taken in the Mason College Laboratory.

The Ordinary Course for Medical Students is given on Tuesdays and Thursdays from 2 to 4 p.m. throughout the Summer Term.

Fees:—

	All day.	Three hours per day.
One Term	7 guineas	4½ guineas.
Two Terms	13 „	8½ „
Three Terms	18 „	12 „

A Course of short demonstrations and exercises will be given by the Professor or one of his Assistants once a week. All first-year Students will be required to attend, unless exempted for special reasons by the Professor. No Fee.

Metallurgy.—Two Courses of about Ten Lectures each will be given in the Winter and Spring Terms (October to March), on Tuesday Afternoons at 2.30, on the Principles and Practice of Metallurgy. Fee for each Course, 10s. 6d.

Arrangements will be made in the Chemical Laboratory for giving instruction in Practical Metallurgy.

Excursions.

During previous Sessions permission has been obtained to visit some of the great factories in or near Birmingham, in which chemical and metallurgical industries are carried on. Students have thus had most valuable opportunities of gaining a practical acquaintance with some branches of Applied Science. The privilege thus courteously granted by several manufacturers will, it is hoped, be enjoyed in every future Session. The excursions will be conducted by the Professor.

BRADFORD TECHNICAL COLLEGE.

Chemistry and Dyeing.—Edmund Knecht, Ph.D.

Assistant.—Charles H. Jessop.

The school year is divided into three terms, and the Session commenced on September 8th and terminates at the end of July.

The course of instruction extends over two years, and embraces Day and Evening Classes and Practical Laboratory work in Chemistry, Dyeing, and Metallurgy.

The tuition fees are arranged for two classes of students,

those paying a reduced sum being expected to sit for the Government Science examinations.

Several exhibitions and scholarships are available for students.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

CHEMICAL DEPARTMENT.

Professor.—Prof. E. Kinch, F.C.S., F.I.C.

Systematic courses of Lectures are given on Inorganic, Organic, and Agricultural Chemistry, illustrated by experiments, and by the collections in the College Museum. They comprise, as preliminary, the laws of Chemical Combination and the general Chemistry of mineral bodies, and of the more frequently occurring bodies of organic origin, with the relationship of their leading groups; and, finally, the Chemistry of the atmosphere, of soils and manures, of vegetation and animal nutrition, and of Agricultural economy.

In the Laboratory practical instruction is given in the construction and use of apparatus and in Chemical manipulation and analysis, both qualitative and quantitative. After studying the simple operations and the properties of the commonly occurring substances, the Students are taught to analyse a series of compounds, and apply the knowledge thus obtained to the analysis of manures, soils, waters, foods and feeding stuffs, and other substances met with in the ordinary course of Agricultural practice. Chemico-agricultural researches are undertaken by the senior Students under the direction of the Professor and his Assistants.

THE YORKSHIRE COLLEGE, LEEDS.

Professor of Chemistry.—Arthur Smithells, B.Sc. Lond., F.C.S.

Assistant Lecturers.—C. H. Bothamley, F.C.S., and Herbert Ingle.

The Session begins October 6, 1885.

Lecture Courses.

1. General Course on Systematic Chemistry—Monday, Tuesday, Thursday, and Friday, at 4 p.m., from October to the end of the second term. Fee for the Course, £5 5s.

2. Lectures on Laboratory Practice and Chemical Calculation—Monday, at 12.30 during the First and Second Terms. Fee, £1 1s.

3. Chemistry as Applied to Coal Mining—Wednesday, during the First Term, at 4 p.m.

4. Organic Chemistry—Tuesday and Thursday at 12.30 p.m., during the Second and Third Terms. Fee £2 12s. 6d.

5. Lectures on Chemical Technology—Will be varied from session to session. During Session 1885-6 a Course of Twenty Lectures "On the Metallurgy of Iron and Steel" will be given on Wednesdays, at 4 p.m., during the Second and Third Terms. Fee £2 2s.

6. A Class on Elementary Chemistry, consisting of about Twenty Lessons, on the Non-metals, will be held on Saturdays, at 12.30 p.m., during the First and Second Terms. Fee for the Lecture Class, 10s. 6d.

7. Photographic Manipulation—A Course of Ten Lessons will be given on Saturdays, during the Third Term, with special reference to dry plate processes and silver and platinum printing. Fee, £1.

Laboratory Courses.

The College Laboratory will be open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session.—Students working six days per week, £18 18s.; five, £16 16s.; four, £14 14s.; three, £12 12s.

Class in Practical Chemistry, Saturday mornings, from 9.30 to 12.30. Fee £1 11s. 6d.

Practical Chemistry for Medical Students.—On Tuesday and Thursday, from 10 to 12 a.m., from May to July.

Evening Classes.

A Course of twenty Lectures by Mr. C. H. Bothamley, on the Elements of Inorganic Chemistry (the Non-Metals) will begin during the first and second Terms, on Wednesdays, at 7.30 p.m., beginning October 15. Fee, 10s. 6d.

Dyeing Department.

Professor.—J. J. Hummel, F.C.S.

This Course extends over a period of three years, and is intended for those who wish to obtain a full scientific and practical education in the art of dyeing. It is suitable for those who purpose in the future to take any part in the direction of the operations of dyeing or printing of textile fabrics, *e.g.*, the sons of manufacturers, calico printers, managers, master dyers, &c.

Several valuable Scholarships are at the disposal of the College, *viz.*, the Cavendish, Salt, Akroyd, Brown, and Clothworkers' Scholarships, and the Leighton Trustees' Exhibition.

UNIVERSITY COLLEGE, LIVERPOOL.

Professor.—Campbell Brown, D.Sc.

The Session commences October 1st. The Chemical Laboratories have been enlarged so as to accommodate 70 Lecture Students and 48 Working Students; the new Chemical Laboratories are approaching completion, and will probably be ready for use in April next.

Students desirous of having a thorough theoretical and practical acquaintance with Technical Chemistry, or who intend to adopt Chemistry as a profession, must devote at least three years to special study. They ought to have an ordinary school acquaintance with English Composition and Latin, and must be proficient in Arithmetic and the elements of Algebra.

They are recommended to adopt the following curriculum:—

First Year.—Chemistry—Course of Lectures on Theoretical Chemistry during the Autumn and Lent Terms; Chemical Laboratory, two days a week, during the Lent and Summer Terms; and the Practical Chemistry Class during the Summer Term. Mathematics, Pure and Applied, Physics or Geology, French or German.

Second Year.—Chemistry—Second Attendance on portions of the Lecture Courses, if necessary; Lectures on Organic Chemistry in the Summer Term. Chemical Laboratory, three days per week, and the Practical Organic Class during the Summer Term. Physics, Mathematics, German or French.

Third Year.—Any of the above-mentioned lectures which have not been attended. Lectures on Organic Chemistry. Chemical Laboratory, four or five days per week. Physical Laboratory, one day per week.

Special Certificates will be granted to those Students who pass through the above or a similar curriculum, and who perform their work and pass the periodical examinations to the satisfaction of the Professors; but these Certificates of Proficiency will only be given to such as can perform Practical Work in a reliable manner. Remunerated appointments are occasionally offered to efficient Students of the third year.

The Sheridan Muspratt Chemical Scholarship of £50 per annum, tenable for two years, will be awarded in December on an Examination in subjects which are included in the first two years of the above curriculum.

The Laboratory is opened for Students from 10 a.m. to 4.30 p.m. daily, on Saturdays from 10 to 1 only.

The Prospectus containing full particulars may be obtained from Adam Holden, 48, Church St., Liverpool, price 6d.; or from the Registrar, University College, Liverpool.

LIVERPOOL COLLEGE OF CHEMISTRY.

Principal.—George Tate, Ph.D., F.G.S., F.C.S.

The Laboratories are open daily from 10 to 5, excepting Saturdays, when they close at 1 p.m. The course of in-

struction is adapted to the requirements of students of Chemistry as a science, and in its applications to chemical and metallurgical industries. The fee for a three years' course of study is eighty-five guineas, or per session of three months ten guineas.

Prospectuses, containing full particulars of the day and evening classes, may be had on application at the College.

UNIVERSITY OF DURHAM.

COLLEGE OF PHYSICAL SCIENCE,
NEWCASTLE.

Professor of Chemistry.—P. Phillips Bedson, D.Sc., F.C.S.

Demonstrator.—Saville Shaw.

The Session will commence on September 28th, 1885.

Junior Division.—General Principles of Chemistry. History of the Non-Metallic Elements. History of the Metals and their more important Native and Artificial Compounds. Principles of Qualitative Analysis. Mondays, Wednesdays, and Fridays, at 12.5 p.m. *Senior Division.*—Organic Chemistry. Chemistry of the Carbon Compounds. Tuesdays and Thursdays, at 11. Fee, £5 5s. Commencing Tuesday, October 6th.

A Special Course will be given on Applied Chemistry, commencing Thursday, October 1st. Fee, £2 2s.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. *Laboratory Fees.*—Students working six days per week, £5 5s. per term; alternate days, £3 3s.; one day per week, £1 1s.

Courses of Study.—Students will be divided into two classes:—(1) Regular, or Matriculated Students; and (2) Non-Matriculated Students. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the title of Associate in Physical Science. Non-Matriculated Students will attend such classes as they may select. Every candidate for admission as a matriculated student must pass an examination on entrance, in reading, writing from dictation, English or Latin Grammar, arithmetic (including decimals), and geography. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the two following examinations:—

1. Durham Examination for certificate of proficiency in General Education, held in March and September.

2. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

Associateship in Physical Science.—Every candidate for the Associateship in Physical Science will be required to satisfy the examiners in three, at least, of the four subjects,—Mathematics, Physics, Chemistry, and Geology,—in an examination, to be held at the beginning of his second year.

The examination in Chemistry comprises:—General Principles of Chemistry. Elements of Inorganic Chemistry. Elements of Qualitative Analysis, including a Practical Examination.

The examination in Chemistry for Candidates at the end of their second year comprises:—Elements of Organic Chemistry and Applied Chemistry. Advanced Qualitative Analysis, including a Practical Examination. Elements of Quantitative Analysis.

Exhibitions.—Three Exhibitions of the value of £25, £15, and £10 respectively will be awarded in October next to Candidates desirous of attending the first year course of study in the College.

Candidates must send their names to the Secretary, on or before the 19th of September, and specify, at the same time, the special subject in which they desire to be examined.

The examination will be held at the College, and will commence on Monday, September 28th.

Two Exhibitions of £15 each will be awarded at the next examination of "Persons not members of the University," which will be held at Durham in March next.

Several other valuable Scholarships are available for students.

OWENS COLLEGE, VICTORIA UNIVERSITY, MANCHESTER.

Professor and Director of the Chemical and Metallurgical Laboratories.—Sir H. E. Roscoe, LL.D., Ph.D., F.R.S., F.C.S.

Professor of Organic Chemistry.—C. Schorlemmer, F.R.S.

Demonstrators and Assistant Lecturers.—Watson Smith, F.C.S., Harry Baker, F.C.S., Julius B. Cohen, Ph.D., and George H. Bailey, D.Sc.

The Session begins on October 6, 1885, and ends on July 2, 1886.

The instruction is given by means of Experimental Lectures and Tutorial Classes. The Chemical Classes form part of the Courses for Chemistry in the University.

Technological Chemistry.

Persons desiring to attend this course will be required to enter the College under the ordinary conditions of studentship.

The object of this course is to offer to students intending to devote themselves more especially to Applied Chemistry as complete a training as the College can provide in those branches of instruction which form the scientific foundation of the subject.

The complete course of instruction extends over four years, and embraces the following subjects:—

First Year.—Chemistry Lectures, Junior. Preparatory:—Chemical Laboratory, two days per week, and Analytical Chemistry Lectures class. Mathematical class, Section I. Experimental Mechanics. Geology (Physiography). French or German. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Second Year.—Chemistry Lectures, Junior* and Senior classes. Chemical Laboratory, three days per week. Technological Chemistry Lectures. Experimental Physics or Mineralogy Lectures and Practical Courses. German or French. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Third Year.—Chemistry Lectures, Senior* classes. Organic Chemistry Lectures. Chemical Philosophy. Chemical Laboratory, three days per week. Technological Chemistry Lectures (second course). Physical Laboratory, 1 day per week, or Advanced Mineralogy Lectures and Practical Course. Mechanical Drawing, Practical (evening class).

Fourth Year.—Organic Chemistry Lectures.* Technological Chemistry Lectures (third and fourth courses). Chemical Laboratory, 4 days per week. Mechanical Drawing, Practical (evening class).

Fees.—Every student is required to pay on admission an entrance fee of £1 rs. and a library fee of 5s., and the fees for the classes for which he enters. As alternative courses are in some instances open to a student offering himself for the Victoria University Examinations, it is not practicable to give tabular statements of the fees for every combination of classes. Special prospectuses may be obtained at the office of the College.

The aggregate of the fees in each year will vary slightly according to the particular class selected in French or German, or to the choice made in respect of the other alternatives proposed.

When a student is excused a second attendance on any of the Chemistry Lecture Courses the fee will be reduced accordingly.

* Students who gain a place in the First or Second class in the annual examinations will be excused a second attendance on these classes.

Certificates will be granted to students on the successful completion of this course. Attendance on the full course of four years is expected of candidates for the Certificate, but students may obtain exemption (on cause shown) from the first or the first and second year's courses. Students so excused will nevertheless be required to undergo examination in all the subjects specified.

The Certificate will state in which subjects the candidate has gained Honours, and in which he has merely satisfied the Examiners.

A number of important Exhibitions, &c., are available to students.

UNIVERSITY COLLEGE, NOTTINGHAM.

Professor of Chemistry—Frank Clowes, D.Sc. Lond., F.I.C., F.C.S.

Demonstrator—Mr. J. B. Coleman, F.C.S.

The Classes of the College are open to students of both sexes above sixteen years of age. In virtue of the affiliation of the College to Cambridge University a suitable course of study is recognised in lieu of part of the ordinary residence at Cambridge for those intending to take degrees at that University. Reference should be made to the College Calendar for fuller information.

Lecture Courses.—A systematic course of day lectures is delivered on Tuesday and Friday afternoons at 4.30: the non-metals are treated of in the Autumn Term (October 5th to December 19th), the metals in the Spring Term (January 25th to April 10th), and the carbon compounds in the Summer Term (April 28th to July 10th).

A course of evening lectures runs parallel with the day course, being delivered on Wednesday evenings at 8 o'clock.

A lecture class in connection with both courses meets on Wednesday evenings at 7 o'clock.

Students may qualify themselves by attendance at these lectures and classes for the Examinations of the Universities of London, Cambridge, or Oxford: they may also obtain instruction in Chemistry for technical or other purposes.

Fees.—For the day lectures, £2 10s. for the session, and one guinea for a term; for evening lectures, 2s. 6d. per term; or 5s. for lectures and classes.

Courses of Lectures will also be delivered upon Pharmaceutical Chemistry, the Chemistry of Bread-making, the Chemistry of Dyeing and Bleaching, and the Distillation of Coal-tar.

Practical Chemistry.—The chemical laboratory is open every day except Saturday from 10 to 1 and from 2.30 to 5.30, also on Tuesday and Thursday evenings from 7 to 9. Each Student works independently of other Students at a course recommended by the Professor. Instruction is given in general Chemical Manipulation and in Qualitative and Quantitative Analysis; and students are enabled to work out the applications of Chemistry to Pharmacy, Dyeing, Bread-making, Agriculture, Brewing, and other Manufacturing Processes. A set of ordinary apparatus and reagents and a private locker are supplied free of charge, for the safe keeping of which the Student is held responsible.

Fees.—For day students for three hours weekly 20s., for six hours 35s., for nine hours 50s., and 10s. extra for each additional three hours per week; for evening students 10s. for one evening per week, and 20s. for two evenings per week.

Government Lectures and Classes.—Evening Lectures and Laboratory instruction will be given by the Demonstrator of Chemistry to Students who intend to present themselves for Examination by the Government Science and Art Department in May next. Inorganic, organic, and practical chemistry will be taught in the elementary and advanced stages, each of which commences at the beginning of the College Session in October. Fees for each Lecture Course, 2s. 6d.; for each Laboratory Course, 5s. Students joining these classes are expected to become candidates for the Government Examinations in May.

FIRTH COLLEGE, SHEFFIELD.

Professor of Chemistry.—W. Carleton Williams, B.Sc., F.C.S.

Demonstrator and Assistant Lecturer.—L. T. O'Shea, F.C.S.

The Session will commence on Tuesday, October 6, 1885.

First Year's Course.—Chemistry of the Non-Metallic Elements. Monday, Wednesday, Friday, from 10 to 11 a.m. Fee, £3 13s. 6d.

Second Year's Course.—Chemistry of Metals. Tuesday and Thursday, from 10 to 11 a.m. £2 2s.

Third Year's Course.—Organic Chemistry, on Tuesday, Thursday, and Saturday, from 10 to 11. Fee, £1 11s. 6d. Chemical Philosophy, on Saturday at 10. Fee, £1 1s.

Analytical Chemistry.—Lecture course by Mr. O'Shea. Thursday, 11 to 12. Sessional fee, £1 11s. 6d.

Laboratory.—Working hours to be arranged between Professor and Students.

Sessional Fees for Day Students:—Six hours per week, £4 10s.; Nine, £6 10s.; Twelve, £8; Eighteen, £11 4s.; Twenty-four, £14; Thirty, £16 16s.; Thirty-six, £19.

Day Students may not enter for less than six hours a week. Students joining the Laboratory at Christmas will be charged two-thirds and at Easter one-third of the Fees for the whole Session.

Fees for short periods (working thirty-six hours per week):—For one month, £3 13s. 6d.; two months, £6 6s.

An arrangement has been entered into with the Science and Art Department, South Kensington, which will enable Science Teachers to work in the Chemical Laboratory for twelve hours a week on payment of one-quarter of the usual fee, the Department being willing to pay the remainder under certain conditions, of which full information may be obtained on application to the Registrar.

Evening Classes.—Lectures, Wednesday, 8 to 9. Laboratory instruction, Monday and Wednesday, 6 to 9. Sessional Fee, one evening per week, £1 10s.; two, £3; or Lecture Class and Laboratory, on Wednesday evening, £1 10s.

UNIVERSITY COLLEGE, DUNDEE.

Professor.—T. Carnelley, D.Sc., F.C.S.

Lecture Assistant.—Andrew Thomson, M.A., B.Sc.

The second session of the College will be opened on October 7th, 1885.

The Lectures and Laboratory practice in Chemistry are recognised by the Royal College of Physicians and Royal College of Surgeons, London, and by the Royal College of Surgeons, Edinburgh, and for degrees in Science and Medicine by the University of Edinburgh.

The courses are suitable for the Degrees of the London University and for the Civil Service appointments, and will also satisfy the requirements of students in Pharmacy, and of students who intend to become candidates for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

Lecture Courses.

The object of these courses will be (1) to give systematic instruction in the general principles of the science, and information regarding the elements and their more important compounds; (2) to show how this knowledge may be usefully applied in the Arts and Manufactures.

A course of instruction in Practical Chemistry in the Laboratory is recommended to all who wish to obtain a sound knowledge of the science, and the methods of applying it to useful purposes—the duration of such course depending upon the special wants of the student.—The Professor will be glad to give any information to intending students.

First year's lecture course: Monday, Wednesday, and Friday, from 10 to 11 a.m.; fee, £2 2s.

Second year's lecture course: Tuesday, Thursday, and Saturday, from 9 to 10 a.m.; fee, £2 2s.

Practical Chemistry (Laboratory).

The aim of the Laboratory Courses is to make the student practically acquainted with the science, so that he may conduct chemical analysis and original research, and generally to fit him for applying the science to the Arts, Manufactures, and Agriculture. The courses are also suitable for students preparing for their medical and pharmaceutical examinations. A three months' course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health, may be taken in the College Laboratory.

The Laboratory will be open for students daily from 9 a.m. to 4 p.m., except on Saturdays, when it will be closed at 3 p.m. Each student on entering will be allowed to arrange his working hours to suit his own convenience, but will be required to keep the hours when once fixed.

Sessional Fees for Day Students:—The fees for both sessions are—for six hours per week, £3 3s.; each additional hour per week, 10s. 6d. Day students may not enter for less than six hours a week. Students joining the Laboratory during the second term will be charged two-thirds, and during the third term one-third of the above fees. Students may also enter for short periods, working every day in the week at the following fees:—For one month, £2 12s. 6d.; for two months, £5; for three months, £7 7s.

Evening Classes.—Courses of Lectures and Practical Laboratory instruction.

UNIVERSITY OF EDINBURGH.

Professor.—A. Crum Brown, F.R.S.E.

The Session will commence on October 27, 1885.

Two degrees in Science are conferred by the University of Edinburgh, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.). Both these degrees are conferred in Physical and Natural Science, in Public Health, and in Engineering.

Candidates for degrees in Physical and Natural Science must pass a preliminary examination in English, Latin, Arithmetic, the Elements of Mathematics, and the Elements of Mechanics, and in at least two of the following subjects:—Greek, French, German, Higher Mathematics, Natural Philosophy, Logic, and Moral Philosophy.

The First B.Sc. Examination embraces Mathematics, Natural Philosophy, Chemistry, Zoology, including Comparative Anatomy, and Botany. The Second B.Sc. Examination the Higher Mathematics, Natural Philosophy, Experimental Physics, Chemistry, Zoology, Botany, Physiology, and Geology.

The D.Sc. Examination embraces Mathematics, Applied Mathematics, Experimental Physics, Practical Astronomy, Chemistry, Zoology and Comparative Anatomy, Animal Physiology, Botany, and Geology, including Palæontology and Mineralogy.

ANDERSON'S COLLEGE, GLASGOW.

Professor of Chemistry.—William Dittmar, F.R.S.E.

Chief Assistant.—John M'Arthur.

Laboratory Assistants.—Archibald Kling and Frank Lyall.

Junior Assistants.—James Robson and William Cullen.

A Course of 100 Experimental Lectures on Chemistry: Daily, Saturdays excepted, from 10.15 to 11.15, commencing on Wednesday, Oct. 28th. The Lectures up to the end of the year are devoted to an Elementary Exposition of the Philosophy and the Methods of the Science, as illustrated by the History of the Non-metallic Elements. The rest of the Session is divided between the Chemistry of the Metals and Organic Chemistry, selected chapters. In addition to occasional extemporised examinations during class hours, five written examinations are held during the Session, on Saturdays from 10 to 1. Fee, £2 2s.

The Laboratory is open daily (Saturdays excepted) during the Winter Session from 10 to 5, during Summer from 9-30

to 5: Advanced students may obtain permission to work privately on Saturdays also until 1 p.m. The teaching is conducted on the tutorial system, each student working by himself, at a separate place, and on his own subject. Hence students of any grade of advancement may enter at any time, and the course of instruction can be adapted to the special requirements of the individual. Original research is not forgotten, but Mr. Dittmar makes it a strict rule not to use his students as his private assistants in connection with his own investigations, and to rather discourage original research with students who have not yet obtained a sufficient mastery of all the practically important methods of chemical analysis and of preparative chemistry. Fee per month, £2 2s.; due in advance. For any period of six months or more, if paid in advance, at the rate of £1 15s. per month. The fees include the use of all the ordinary reagents, and of the resources of the laboratory generally; but the student has to find his own small apparatus (test-tubes, beakers, &c.), and also a few of the more expensive reagents—*e.g.*, chloride of platinum, nitrate of silver, molybdate of ammonia.

Of the several duties which the prestige and traditions of this Chair impose upon its occupant, the first and foremost is to offer to young men, of even limited means, the opportunity of receiving a training in chemistry sufficient to prepare them fully for positions in chemical works, or as professional chemists.

A special Practical Class for Medical Students, meeting twice a week for two hours each time, is conducted during the Summer Session. Fee, including all expenses, £2 2s.

The Evening Department opens on the 2nd of October.

THE "YOUNG" CHAIR OF TECHNICAL CHEMISTRY, ANDERSON'S COLLEGE.

Professor.—Edmund J. Mills, D.Sc. (Lond.), F.R.S.

Assistant.—Mr. C. Ellis.

This Chair has for its object the instruction of Students in Chemistry as applied to the various branches of industry in Chemical and other works, Metallurgy, Agriculture, &c.

LECTURES.—*Principal Course.*—A Course of Twenty-five Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m., commencing on November 2nd. The Lectures will be illustrated with Experiments, Diagrams, and Models, as well as by the actual Inspection of Manufacturing Processes; and the progress of the Students will be tested by periodical Examinations. These Lectures will have reference to units of weight and measure, to the calculations necessitated by Chemical operations, and to the nature and laws both of the Chemical process and its results, as illustrated in Chemical Technology.

Fee for the Course, One Guinea.

Subsidiary Course.—A subsequent Course of Thirty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m. This Course is more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalers, and others interested in a knowledge of Technical Organic Chemistry.

Fee for the Course, Two Guineas.

Evening Courses.—There will be a special evening course of twenty-five lectures on Oils, Paints, and Varnishes.

There will be Practical Evening Classes in the following subjects:—Oils, Paints, and Varnishes; Bleaching, Dyeing, and Printing; Iron and Steel; Water Supply and Sewage.

Laboratories.—The Laboratories are open daily from 10 to 4, and on Saturday from 10 to 1 o'clock for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months, or £2 10s. per month.

Students must have a fair acquaintance with elementary Chemistry.

The New Laboratory Buildings comprise four stories, with a lecture room in the rear, and are exclusively devoted to the purposes of this Chair.

The Trustees, having had under consideration the requirements of Inventors, Patentees, and others whose investigations require isolation and privacy, as well as professional advice, have included in the arrangements Five Private Laboratories. Electric Cable has been laid to these laboratories for the supply, if required, of adequate power.

Library.—A Students' Library Society was founded in 1875. Its objects are to provide a collection of standard chemical works, and to maintain a regular supply of chemical journals. A large number of works have already been purchased or bestowed, and nine journals are received. Annual subscription, Half-a-crown.

QUEEN'S COLLEGE, BELFAST.

Professor.—E. A. Letts, Ph.D., F.R.S.E., F.C.S.

The Session begins October 20th.

I.—Chemistry.—The lectures are delivered at 3 p.m., on the first five days of each week until the beginning of April, and on two days of each week after May 1st. The course is divided into three parts:—(1) Chemical Philosophy; (2) Inorganic Chemistry; (3) Organic Chemistry.

II.—Advanced and Organic Chemistry.—Lectures on these subjects are given from the beginning of the Session, on Tuesdays and Thursdays, at 10 a.m., until the beginning of April, and on the same days at 3 p.m., after May 1st.

III.—Practical Chemistry.—In this course the Students are instructed in the general methods of conducting Chemical Analyses.

IV.—Laboratory Pupils.—The Chemical Laboratory is open from November until the beginning of April, and from May 1st until the middle of July, on the first five days of the week, from 10 a.m. until 4 p.m. The course of instruction is under the direction of the Professor of Chemistry, and of the Chemical Assistant. Students are admitted as working pupils on payment of a fee of £5 for the first period, or of £3 10s. for the second period (or for a single term).

QUEEN'S COLLEGE, CORK.

Professor.—Maxwell Simpson, D.Sc., M.D., F.R.S., &c.

The Session begins October 20th. The Chemistry Classes are held on Mondays, Wednesdays, and Fridays.

The Course is divided into Inorganic and Organic Chemistry.

In the first part are discussed the Laws of Combination and Affinity, Molecular Chemistry and Crystallography, and the History of the Non-Metallic and Metallic substances.

In the Organic portion of the Course will be considered the subjects of Organic Analysis, Organic Series, Compound Radicals and Types, Metamorphosis of Organic Bodies, History of Special Animal and Vegetable Bodies.

In treating of the Laws of Chemistry, and the History of Inorganic and Organic Bodies those points will be chiefly dwelt upon which have a practical bearing in the Arts, Medicine, Engineering, and Agriculture. Thence, during the Course, attention will be directed to the application of Chemistry to Medicine and Physiology, to Metallurgical Operations, Chemical Manufactures, Building Materials, Soils, and Manures.

Fee.—For each Sessional Course, £2. Each subsequent Course in Medicine, £1.

The Chemical Laboratory is open daily except on Saturdays, from 10 to 4 o'clock, under the Superintendence of the Professor, to Students desirous of prosecuting an extended course of qualitative and quantitative analysis, and for the purpose of original investigation in connection with the Arts, or in the higher departments of Scientific Chemistry.

UNIVERSITY OF DUBLIN.
TRINITY COLLEGE.

Professor of Chemistry.—J. Emerson Reynolds, M.D., F.R.S.

Senior Assistant and Demonstrator.—William Early, F.I.C.

The professor of chemistry lectures on Elementary Chemistry during the whole of Michaelmas and Hilary Terms, on the Non-Metals and Metals; and the students repeat in the Laboratories many of the experiments shown at lecture.

The advanced course consists chiefly of Laboratory instruction in qualitative analysis (including spectrum analysis) commencing in Michaelmas Term, about November 1st. Volumetric and gravimetric analysis, commencing in Hilary Term. Organic preparations and analysis, commencing in Trinity Term.

Professor Reynolds lectures on Organic Chemistry during Trinity Term. In the main Laboratory facilities are afforded for the prosecution of experimental researches.

ROYAL COLLEGE OF SCIENCE FOR IRELAND,
STEPHEN'S GREEN, DUBLIN.

Professor of Practical and Theoretical Chemistry.—W. Noel Hartley, F.C.S.

The Session commences on Monday, October 5, 1885.

The instruction comprises courses of Lectures on General, Applied, and Analytical Chemistry, and also a course of Lectures on Metallurgy.

The Chemical and Metallurgical Laboratories, under the direction of Mr. Hartley, are open every week-day during the Session, except Saturday. Instruction is given in the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical Research. Fee, for the Session of nine months, £12; or for three months, £5; or for one month, £2.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to Students who have been a year in the College. There are also nine Exhibitions attached to the College, of the yearly value of £50 each, with Free Education, including Laboratory Instruction, tenable for three years; three become vacant each year.

A Diploma of Associate of the College is granted at the end of the three years' course.

Evening Classes.—Systematic Courses of Evening Lectures are given by most of the Professors throughout the Session.

CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

CITY AND GUILDS OF LONDON INSTITUTE FOR THE ADVANCEMENT OF TECHNICAL EDUCATION, TECHNICAL COLLEGE, FINSBURY.—Professor, H. E. Armstrong, Ph.D., F.R.S. The College fulfils the functions of a finishing technical school for those entering industrial life at a comparatively early age; of a supplementary school for those already engaged in the factory or workshop; and of a preparatory school for the Central Institution. It is under the general direction of the Principal or Superintendent of Studies. At the head of each Department is a Professor, who is assisted by one or more Demonstrators; and besides these there are Lecturers and Teachers for instruction in special subjects: Skilled Artizans are employed in the Workshops for the guidance of the Students. The Session is divided into three terms:—The Winter term commences on Monday, October 5th, and ends on December 23rd; the Spring term commences on the second Monday in January, and ends on the

19th of March; the Summer term commences on the 12th of April and ends on July 2nd, the evening classes terminating in June. An examination for the admission of Students will be held at the College at 10 o'clock on Thursday, October 1st, 1885, and the work of the Session will commence on Monday, October 5th. The instruction consists of Day and Evening Classes and Laboratory Instruction.

CITY OF LONDON COLLEGE.—Evening Classes in Chemistry, Physics, Electricity, and other Science subjects.

BIRKBECK LITERARY AND SCIENTIFIC INSTITUTION, BREAM'S BUILDINGS, CHANCERY LANE.—*Organic Chemistry*: A course of 30 Lectures, beginning on October 6th, at 7 p.m., by Mr. H. Chapman Jones, F.C.S. A supplementary Course of about twelve lectures for more advanced students begins in January. Laboratory work and Analysis on Tuesdays, from 8 to 10 p.m. Special facilities are provided for students preparing for the Second B.Sc. (London) Practical Chemistry Examination. *Photography*: A course of Thirty Lectures, with Demonstrations on the Theory and Practice of Photography, by Mr. H. Chapman Jones, beginning at 7 p.m., on October 7th. *Inorganic Chemistry*: A course of Thirty lectures to Elementary Students, beginning on October 6th, and a similar course to Advanced Students, beginning on October 10th, by Mr. George Chaloner, F.C.S. Classes for Practical Chemistry and Analysis on Tuesday and Saturday evenings, beginning on October 6th, conducted by Mr. George Chaloner.

CRYSTAL PALACE COMPANY'S SCHOOL OF ART, SCIENCE, AND LITERATURE. SCHOOL OF PRACTICAL ENGINEERING. *Principal*—Mr. J. W. Wilson, Memb. Inst. C.E.—This school was established with the purpose of affording to Students of Civil or of Mechanical Engineering the advantage of thorough practical instruction in the rudiments of either profession, and in the manipulation of materials. The leading object is to prepare Students, by systematic practical instruction, for professional articles, so that on entering an Engineer's office or works the pupil may at once be useful to his Principal, and enabled to take advantage of the opportunities for learning open to him, because he has mastered the elementary details of the profession. The school is also available for Students already articulated, who desire instruction in either the offices or shops. The Colonial Section is designed particularly for gentlemen who are going to the Colonies or abroad, as explorers or settlers. The object proposed is to afford them so much practical knowledge of scientific and mechanical work and expedients as shall enable them best to utilise the means at their disposal, especially when entirely dependent on their own resources.

Ladies' Division.—The School was established to utilise the valuable Courts and Collections of the Crystal Palace for the purposes of instruction in Art, Science, Literature, &c., so that education of the highest class might be afforded under most advantageous conditions. The system of tuition is mainly by private tutorial instruction, but other subjects are taught on the University method, in accordance with the regulations laid down by the Syndicate of the University of Cambridge, by whom some of the lectures and classes are conducted. A student may take lessons in one or several studies at option. The School is a centre for both the University of Oxford and the University of Cambridge Local Examinations, the Oxford Examination for Women, and for the Cambridge Higher Local Examination. The following examinations will be holden in the Ladies' Division during 1885-86:—Cambridge Local, December, 1885; Oxford Local and Oxford Examination for Women, June, 1886; Cambridge Higher Examination, June, 1886. The session opens on October 1.

NEW CENTRAL SCHOOL OF CHEMISTRY AND PHARMACY, 173, Marylebone Rd., London.—Mr. J. Woodland, F.C.S., M.P.S., and Mr. J. F. Burnett, F.C.S., M.P.S. In addition to the usual Chemical studies, Special Instruction Classes are held for Students of Medicine,

SOUTH LONDON SCHOOL OF CHEMISTRY, 325, Kennington Road.—Dr. John Muter, F.C.S. Daily, at 10 a.m. Lectures on Theoretical Chemistry, and Junior and Senior Course of Practical Chemistry.

SOUTH WEST LONDON CENTRAL SCHOOL OF CHEMISTRY AND PHARMACY, 183, King's Road, Chelsea.—Special Classes for Students of Medicine. Mr. W. H. Martin.

ST. JOHN'S TRAINING COLLEGE, Battersea.—Both Theoretical and Practical Chemistry form part of the curriculum of the College.

THE WESTMINSTER COLLEGE OF CHEMISTRY AND PHARMACY, Trinity Square, S.E.—Messrs. Wills and Wootton. Daily, at 9 a.m. Theoretical and Practical Chemistry. Also Evening Classes, at 7.

SCHOOL OF PHARMACY OF THE PHARMACEUTICAL SOCIETY OF GREAT BRITAIN, 17, Bloomsbury Square.—The school opens on Thursday, the 1st of October. Lectures on Chemistry and Physics, by Prof. Wyndham Dunstan, on Monday, Tuesday, and Wednesdays, at 9 a.m. The Laboratories for Practical Instruction in Chemistry as applied to Pharmacy, &c., under the direction of Prof. Attfield, assisted by Mr. F. W. Short, and Mr. Eastes, will be open daily at 10 a.m. throughout the Session. They are fitted up with every convenience for the study of the principles of Chemistry by personal experiment. They are specially designed for the student of Pharmacy, but are equally well adapted for the acquirement of a knowledge of Chemistry in its application to Medicine, Manufactures, Analysis, or Original Research. There is no general class for simultaneous instruction, each student following an independent course of study always determined by his previous knowledge; pupils can therefore enter for any period at any date. Fees for the Lectures, One Course, £3 3s.; an entire Session—Two Courses, £4 4s.; Perpetual Admission, £5 5s.; for Practical Chemistry, 10 months, 12 to 25 guineas, according to hours of attendance. *Council Prizes*.—At the end of each of the five months Courses of Lectures on Chemistry and Physics, and Botany and Materia Medica, a Bronze Medal and Certificates of Merit, and at the close of the Session (ten months) a Silver Medal and Certificates of Honour and Merit, are offered for competition by the Council. In the Class of Practical Chemistry, a Silver Medal, two Bronze Medals, and Certificates of Honour and Merit, offered by the Council, are competed for at the end of the Session.

ONSLOW COLLEGE OF SCIENCE, 183, Kings Road, Chelsea, S.W.—Lectures and Laboratory instruction in Chemistry and Pharmacy. Special Evening Classes in Inorganic and Organic Chemistry, &c. The Chemical and Metallurgical Laboratories are open every day and evening for practical work. Principal, Mr. W. H. Martin.

BIRMINGHAM.—QUEEN'S COLLEGE.—In connection with this College the Chemistry Lectures are given at Mason Science College, by Prof. W. A. Tilden.

BRISTOL MEDICAL SCHOOL.—Mr. T. Coomber, F.C.S.

DERBY CENTRAL SCHOOL OF SCIENCE.—Evening Lectures and Practical Laboratory Instruction, commencing September 25. Physics and Mathematics—H. Barfield, D.Sc. Chemistry—Mr. Small, B.Sc.

COLLEGE OF CHEMISTRY, ROYAL INSTITUTION, HULL. Professor G. Carr Robinson, F.R.S.E., F.I.C., F.C.S. Lectures on Inorganic and Organic Chemistry and on the Manufacture of Oils, Colours, and Varnishes are given during the Winter months. Winter Session begins first week in October.

INSTITUTE OF CHEMICAL TECHNOLOGY, Hackins Hey, Liverpool.—Principal, Mr. A. Norman Tate, F.I.C. The course of instruction is intended more especially for students who wish to gain a knowledge of chemistry and the allied sciences in their relation to industrial and commercial pursuits, and embraces a thorough preliminary course of theoretical chemistry and practical laboratory work, followed by instruction in chemical technology fitted to the requirements of each pupil. In addition to these

chemical studies, students who desire it can enter upon a special course calculated to afford them knowledge useful in the erection and arrangement of manufactories and plant, and construction of apparatus. Fee: Fifty guineas per annum, with extra fee according to circumstances for the special course.

LEEDS SCHOOL OF MEDICINE.—Prof. Smithells.

THE TECHNICAL SCHOOL, MANCHESTER.—Lecturer and Director of the Chemical and Metallurgical Laboratories. Dr. A. B. Griffiths, F.R.S.E., F.C.S.; Demonstrator, Mr. E. L. Rhead.—The Session begins on September 28th. The Chemical Lectures and Laboratory Demonstrations are held on Mondays, Wednesdays, and Fridays. There will be a Junior Course of Inorganic and Organic Chemistry, including about Six Lectures on Historic Chemistry and Ten Lectures on Chemical Philosophy. The Laboratories are fitted with every convenience for chemical analysis and practical chemistry, they are opened daily (except Saturday) from 10 to 1, and in the evenings from 8 to 9.30. Throughout the Session there will be Evening Lectures on Pure and Applied Chemistry. Demonstrations will be given in the Metallurgical Laboratory in the Art of Assaying and Metallurgical work generally. Further particulars may be obtained from the Secretary.

QUEENWOOD COLLEGE, near Stockbridge, Hants.—Mr. M. Whitley Williams, F.C.S. Lectures on Inorganic Chemistry and Physics and Laboratory Instruction.

SHEFFIELD BOROUGH ANALYSTS' LABORATORY, 1, Surrey Street.—Mr. A. H. Allen, F.C.S. Day and Evening Classes.

UNIVERSITY OF ABERDEEN.—Mr. J. S. Brazier, F.C.S.

SCHOOL OF MEDICINE, SURGEON'S HALL, EDINBURGH.—Dr. Stevenson Macadam, F.R.S.E., Mr. Falconer King, Mr. Ivison Macadam, and Mr. Drinkwater.

EDINBURGH SCHOOL OF PHARMACY AND CHEMISTRY.—The instruction qualifies for graduation in Medicine and Science in the University of Edinburgh and other Examining Boards. Chemistry, Mr. C. H. Stewart, B.Sc. Botany, Mr. A. D. Sloan, B.Sc. Materia Medica and Pharmacy, Mr. R. Urquhart.

EDINBURGH SCHOOL OF MEDICINE, 41, Chambers St.—Dr. Drinkwater, F.C.S.—The instruction here qualifies for all Medical Boards, Edinburgh University, London University, &c. Day and Evening Classes.

MINTO HOUSE MEDICAL SCHOOL, CHAMBERS STREET, EDINBURGH.—Mr. J. Falconer King, F.I.C., F.C.S. Lectures and Classes.

NEW VETERINARY COLLEGE, LEITH WALK, EDINBURGH.—Professor Ivison Macadam.

SCIENCE SCHOOLS, FALKIRK.—Mr. Andrew Wilson and Assistants. Day and Evening Classes in Theoretical and Practical Chemistry and Metallurgy.

GLASGOW UNIVERSITY.—Prof. J. Ferguson.

GLASGOW VETERINARY COLLEGE.—Professor Cooke.

COLLEGE OF SCIENCE AND ARTS, GLASGOW.—Mr. A. Humboldt Sexton. Day and Evening Classes.

SCHOOL OF CHEMISTRY, 138, Bath Street, Glasgow.—Dr. Wallace, Mr. Tatlock, and Dr. Clark. Day and Evening Classes.

CHEMICAL LABORATORY, 180, West Regent Street, Glasgow.—Dr. Milne. Day and Evening Classes.

QUEEN'S COLLEGE, GALWAY.—Dr. T. H. Rowney.

ROYAL COLLEGE OF SURGEONS IN IRELAND.—Sir Charles Cameron, F.I.C. The Laboratories of the College are provided with every appliance for the study of Chemistry, especially in its application to Medicine, Hygiene, and Pharmacy.

DUBLIN, CARMICHAEL COLLEGE OF MEDICINE.—Dr. C. R. C. Tichborne.

DUBLIN, CATHOLIC UNIVERSITY.—Dr. Campbell.

DUBLIN, DR. STEEVENS'S HOSPITAL AND MEDICAL COLLEGE.—Mr. McHugh.

MECHANICS' INSTITUTE, Abbey Street, Dublin.—Mr. Clement J. Leaper.

ADDRESS TO THE CHEMICAL SECTION
OF THE
BRITISH ASSOCIATION.

By Prof. HENRY E. ARMSTRONG, Ph.D., F.R.S., Sec. C.S.,
President of the Section.

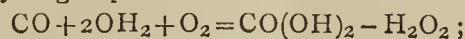
(Concluded from page 139.)

It is possible that a precise estimate of what, for want of a better name I have spoken of as residual affinity, may sooner or later be obtained, if the view Professor Lodge has propounded in his paper "On the seat of the Electromotive Forces in a Voltaic Cell" be correct, that the cause of the volta effect is the *tendency to chemical action* between the bodies in contact: that, for example, chemical strain at the air-contacts is the real cause of the apparent contact-force at the junction of two metals in air. Prof. Lodge, if I understand his argument, appears to assume that the air effects are in some way dependent on the presence of "dissociated oxygen atoms." I think this is probably an entirely unnecessary assumption; of late years, no doubt, it has been the fashion to attribute the occurrence of changes of various kinds to the presence of products of dissociation, but probably to a very unnecessary extent. Recent investigations to which I have alluded show that there are other factors of extreme importance: for example, that water must be present in order to render a mixture of carbonic oxide and oxygen explosive. Again, the observations of V. Meyer and Langer have shown that, whereas chlorine *violently attacks* platinum at low temperatures, it is *without action* upon it at temperatures between about 300° and 1300°, but then *again begins to act* upon it, the action becoming violent at 1600° to 1700°. I have little doubt that the action at low temperatures is dependent upon the presence of moisture; if it were due to dissociated chlorine atoms, the action should increase with rise of temperature without break. In short, I see no reason to assume that oxygen at ordinary temperatures consists of other than diatomic molecules, and this conclusion would also lead me to disbelieve entirely in the explanation of electrolysis which Clausius has given. Assuming Prof. Lodge's view to be correct, the strain exists in virtue of the attraction which the oxygen molecules exert upon the metal molecules. On this assumption, I can well understand that the method of calculation followed by Professor Lodge will not uniformly lead to satisfactory results. The "heat of combination" is not necessarily a measure of "affinity." The values are in all cases algebraic sums of a series of values, scarcely one of which is known, and, as I have already pointed out, the affinities of the molecules are by no means always of the same order as the affinities of the constituent atoms; for example, in all probability, oxygen-stuff has a higher absolute affinity than sulphur-stuff; chlorine-stuff a higher absolute affinity than iodine-stuff, yet iodine and sulphur compounds, more often than not, seem to exhibit more residual affinity than chlorine and oxygen compounds. So that, from Professor Lodge's point of view, chlorine would have the higher and iodine the lower contact values; whereas, from my point of view the reverse might often be the case. I point this out because it appears to me that we here have an opportunity of testing the question experimentally, and seeing that it is possible practically to prevent chlorine from attacking metals by excluding moisture, I do not take the hopeless view that Professor Lodge and others seem to hold regarding the possibility of settling the important question of pure contact *versus* chemical action by appeal to experiment. I may also point out that according to my hypothesis it is possible that the metals may exert a considerable attraction for each other, especially those having monatomic molecules: * many alloys are undoubtedly compounds; possibly

not a few are compounds of the "molecular aggregate" class.*

To return now for but a few moments to the subject of chemical change and its intimate connection with electrical phenomena. One application I would make of the views here put forward would be to explain the superior activity of bodies in the *nascent state*, and in particular of nascent-hydrogen. Briefly stated, I believe it to consist in the fact that nascent hydrogen is hydrogen in circuit—hydrogen in electrical contact with the substance to be acted upon. The experiments of Faraday and of Grove afford the clearest evidence that in order to bring about action between hydrogen and oxygen at ordinary temperatures it is merely necessary to make them elements in a voltaic circuit. The difference in the effects produced by "nascent hydrogen" from different sources is, I imagine, attributable to the variations in E.M.F., which necessarily attend variations in the constituent elements of the circuit.

It is not so easy, however, as yet to explain some of the changes which take place at high temperatures. Mr. Dixon's experiments have proved that a mixture of carbonic oxide and oxygen is non-explosive, but that explosion takes place if moisture be present, the velocity of the explosive-wave depending upon the amount of water present. When the mixture of the two gases is "sparked," change takes place, but only in the path of the discharge. Mr. Dixon considers "that the carbonic oxide becomes oxidised at the expense of the water, the hydrogen *set free* then becoming reoxidised. Mr. Traube, who in a series of papers has called attention to the importance of water in promoting oxidation, has suggested that the oxygen and carbonic oxide together act on the water, forming hydrogen peroxide and carbonic acid:—



and that the peroxide then reacts with carbonic oxide:—
 $\text{CO} + \text{O}_2\text{H}_2 = \text{CO}(\text{OH})_2$. The carbonic acid, of course, is resolved into carbon dioxide and water (*Berichte*, 1885, p. 1890). Traube actually shows that traces of hydrogen peroxide are formed during the combustion. It appears to me that the water may exercise the same kind of action as it (or rather dilute sulphuric acid) exercises in a Grove's gas battery, and that its hydrogen does not become free in any ordinary sense. The production of hydrogen peroxide is not improbably due to a secondary simultaneous change.

Unlike a mixture of carbonic oxide and oxygen, a mixture of hydrogen and oxygen is violently explosive. If we assume that in both cases the reacting molecules are electrolysed by the very high E.M.F. employed, and that the atoms then combine, it is difficult to explain the difference in the results. Does it arise from the fact that hydrogen is an altogether peculiar element? Or are we to attribute it to an influence which water itself exercises upon the formation of water from hydrogen and oxygen—as in the Grove gas battery? It is noteworthy that the velocity of the explosive-wave in electrolytic gas, accord-

molecules powerfully attract each other, and hence that their molecular composition is relatively simple; and on this view the atomic heats of carbon, and of a number of other non-metals and of some metalloids, is low, owing to the extent to which the affinity of the atoms is, as it were, exhausted in the formation of their molecules. Comparison of the "molecular heats" of chlorides and similar compounds with those of the oxides lends much support to this view: as we have reason to believe that the chlorides—which have high "molecular heats"—are of relatively simple molecular composition, and that the oxides—which have low "molecular heats"—are of relatively complex molecular composition.

* The study of alloys from this point of view will probably furnish interesting results. It is noteworthy that the contact difference of potential of brass is less than that of copper, and much less than that of zinc with the same solution in all cases quoted by Ayrton and Perry; thus:—

	Zinc.	Copper.	Brass.
Alum	—0'536 volt.	—0'127	—0'014
Sea-salt	—0'565	—0'475	—0'435
Sal-ammoniac ..	—0'637	—0'396	—0'348

It is especially important to examine the copper-tin alloys, which vary in electrical conductivity in as remarkable a manner.

* Assuming that the heat absorbed in raising the temperature of a solid is mainly expended in overcoming inter-molecular attraction, the high "atomic heat" of metals may be regarded as evidence that their

ing to Berthelot and Vieille, is a close approximation to the mean velocity of translation of the molecules in the gaseous products of combustion calculated from the formula of Clausius (H. B. Dixon, *Phil. Trans.*, 1884, p. 636). And this is also true of mixtures of carbonic oxide and oxygen, and of nitrous oxide and oxygen with hydrogen. May we therefore assume, as the velocity corresponds with that of the products, that the water exercises the important office of inducing change throughout the mass, and not that the hydrogen is peculiar? I am tempted here to suggest that perhaps the "induction" observed by Bunsen and Roscoe in a mixture of chlorine and hydrogen is due to the occurrence of a change in which a something is produced which then promotes reaction between the two gases. I here assume that there would be no action between the pure gases.

If I have allowed myself to flounder in among these difficult questions, it is not because I feel that I am justified in speaking with authority, but in the hope that I may be the "fool," and that the "angels" who are well able to discuss them will be led to do so without delay; for chemists are anxiously awaiting guidance on matters such as I have referred to.

Attention must, however, be directed to the study of electrical phenomena by the recent publications of Arrhenius and of Ostwald (*Journal für Praktische Chemie*, 1884, 30, 93, 225; 1885, 31, 219, 433), and especially by the statement put forward by the latter that the rate of change under the influence of acids (in hydrolytic changes) is strictly proportional to the electrical conductivities of the acids. There cannot be a doubt that these investigations are of the very highest importance.

I trust that in the discussions which we are to have on molecular weights of liquids and solids, and on electrolysis, there may be a free exchange of opinion on some of the points here raised. My reason for selecting these subjects for discussion in this Section will have been made sufficiently clear, I imagine. Last year, in the Physical Section, the idea assumed shape which had long been latent in the minds of many members of the Association, that it is unadvisable, as a rule, to encourage the reading of abstract papers, which rarely are, or can be, discussed. Two important discussions were introduced by Professors Lodge and Schuster. We must all cordially agree with Professor Lodge's remarks on the importance of discussing subjects of general interest at these meetings. It appears to me, however, that even a more important work may often be accomplished if the discussion consist of a series of papers which together form a monograph of the subject. I have endeavoured to carry this idea into practice on the present occasion, and a number of friends have most kindly consented to assist. Unexpected difficulties have arisen, and probably we shall none of us succeed in doing all we might wish. I trust, however, that the Section will approve of this first attempt sufficiently to justify my successors in this chair in adopting a similar course.

I much regret that it is impossible for me to attempt any review of recent work in chemistry. Not a few really important discoveries might be chronicled, and the patient industry of many who have toiled long to win results apparently insignificant should have been mentioned with high approval. A few remarks I will crave permission for, as regarding the general character of the work being done by chemists, and regarding that which has to be done.

Complaints are not unfrequently made in this country that a large proportion of the published work is of little value, and that chemists are devoting themselves too exclusively to the study of carbon compounds, and especially of synthetical chemistry. We are told that investigation is running too much in a few grooves, and it is said that we are gross worshippers of formulæ. Most of these outbursts are attributable to that pardonable selfishness which consists in assigning a higher value to the particular class of work with which one happens to be engaged or interested in than to any other line of investigation; too

frequently they result from want of sympathy with, if not absolute ignorance of, the scope and character of the work complained of. It must not be forgotten that chemical investigation, like other investigation, is to a large extent the work of genius; the rank and file must necessarily follow in the order of their abilities and opportunities: hence it is that we work in grooves. The attention paid to the study of carbon compounds may be more than justified both by reference to the results obtained and to the nature of the work before us: the inorganic kingdom refuses any longer to yield up her secrets—new elements—except after severe compulsion; the organic kingdom, both animal and vegetable, stands ever ready before us; little wonder, then, if problems directly bearing upon life prove the more attractive to the living. The physiologist complains that probably 95 per cent of the solid matters of living structures are pure unknowns to us, and that the fundamental chemical changes which occur during life are entirely enshrouded in mystery. It is in order that this may no longer be the case that the study of carbon compounds is being so vigorously prosecuted: our weapons—the knowledge of synthetical processes and of chemical function—are now rapidly being sharpened, but we are yet far from ready for the attack. As to the value of the work, I believe that every fact honestly recorded is of value; an infinite number of examples might be quoted to prove this. No unprejudiced reader can but be struck also with the improvement in quality which is manifest in the majority of the investigations now published; at no time was more attention given to the discovery of all the products of the reactions studied, and to the determination of the influence of changes in the conditions. As regards our formulæ, those who look upon the outward visible form without proper knowledge of the facts symbolised, and who take no pains to appreciate the spirit in which they are conceived, are undoubtedly misled by them. The great outcome of the labours of carbon-chemists has been, however, the establishment of the doctrine of structure;* that doctrine has received the most powerful support from the investigation of physical properties, and it may almost, without exaggeration, be said to have been rendered visible in Abney and Festing's infra-red spectrum photographs. Some of us look forward to the extension of the doctrine of structure not only to compounds generally but even to the "elements." The relationships between these are in so many cases so exactly similar to those which obtain between carbon compounds, which we are persuaded differ merely in structure, that it is almost impossible to avoid such a conclusion, even in the absence of all laboratory evidence.†

As the field of view opens out before us, so does the vastness of the work to be accomplished become more and more apparent; and Faraday's words of 1834 may be quoted as even more appropriate than a half-century ago:

"Indeed, it is the great beauty of our science, CHEMISTRY, that advancement in it, whether in a degree great or small, instead of exhausting the subjects of research, opens the doors to further and more abundant knowledge, overflowing with beauty and utility, to those who will be at the easy personal pains of undertaking its experimental investigation."

City and Guilds of London Institute.—Old Students' Dinner.—An Old Students' Dinner will take place at the Manchester Hotel, Aldersgate Street, on Thursday, October 1st, at 6.45 p.m. Tickets, prices 3s. 6d., exclusive of wine, may now be obtained of A. C. F. Webb (Sec. *pro tem.*), 53, Stanley Gardens, Belsize Park, N.W.

* I venture here to direct attention to an extension of the acknowledged theory of structure suggested (by myself, I may say) at the close of the discussion of the van't Hoff-Le Bel hypothesis of isomerism in Miller's "Chemistry," vol. iii., 1880 edition, p. 993. The same view was soon afterwards independently put forward by Dr. Perkin.

† F. Exner in a recent paper (*Monatshfte für Chemie*, 1885, p. 249), "On a New Method of Determining the Size of Molecules," actually puts forward an hypothesis as to the structure of elements.

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ADDRESS TO THE MATHEMATICAL AND PHYSICAL SECTION OF THE BRITISH ASSOCIATION.

By Professor G. CHRYSTAL, M.A., F.R.S.E.,
President of the Section.

WHEN a man finds himself unexpectedly in some unusual situation his first impulse is to look round and see how others have done in like circumstances. I have accordingly run through the addresses of my predecessors in the honourable office of President of Section A, which is fated this year to be filled somewhat unworthily. This examination has, I am bound to say, comforted me not a little. I have found precedents for all kinds of addresses, long and short, even apparently for none at all. The variety of subjects is also suggestive of great latitude. I have found reviews of the progress of mathematical and physical science, discussions of special scientific subjects, dissertations on the promotion of scientific research, and on the teaching and diffusion of science, all chosen in their turn for the subjects of this opening address.

Following some of the most eminent of my forerunners, I propose to be brief; following the last of them, Prof. Henrici, I shall take for my subject, so far as I have one, the Diffusion of Scientific Knowledge. Apart from the fact that Prof. Henrici's address greatly interested me, and that I find many of his conclusions in agreement with the results of my own experience, and that, therefore, I wish to second him with all my power, I have other reasons for this choice. For more than half the year I am employed with absolute continuity in teaching mathematics, and it has happened for the last eight years or so that the other half has been mainly occupied in a variety of ways with science-teaching generally. This is the thing concerning which I have had most experience, and I hold it to be the most respectful course towards my audience to speak to them on the subject that I know best.

Ever since I began to study science I have been deeply interested in the question of how it could best be taught. I believe my meditations in that direction were awakened by some unsuccessful boyish efforts to apply to the satisfaction of a ploughman, who was my friend and confidant, certain principles of natural philosophy to explain the action of his plough. Wisely and unwisely I have always been ardent about the improvement of scientific teaching. I was so long before I dreamt that I should one day be called upon to put my ideas through the cold ordeal of practice. It would not be becoming that I should speak at any time, more particularly to-day, regarding the success of my own efforts, or even regarding my alternate fits of hopefulness and despair. It is enough to say that, in such a cause,

"'Tis better to have loved and lost,
Than never to have loved at all."

The British Association, by its title, exists for the advancement of science. Now, I hold that one of the essential conditions for that advancement is the existence of a scientific public—a public, like the Athenians of old, eager to hear and tell of some new truth; eager to discuss and eager to criticise; ready to appreciate what is novel; to receive it if sound, to reject it if unsound. It is to such a public that the British Association appeals, and certainly in the past it has not found its public wanting in generosity. What I should wish to see is less of mere friendly onlooking and more participation in the dance.

I am not speaking now merely of a professional public,

such as is so prominent in Germany, for instance, made up of teachers and others professionally concerned with science. I refer mainly to that amateur but truly expert public which has always been so honourable a feature of English science, as examples of which I may mention Boyle and Cavendish in former days, and Joule and Spottiswoode in our own. It is quite true that much of that scientific public came in days of yore from the leisured class, whose ratio to the rest of the nation will not improbably decrease in the course of our social development. I think, however, that the loss we may thus sustain will be more than compensated by the continual increase of those who have received higher education of some kind or other, and whose daily occupations give them an interest, direct or indirect, in one or more branches of science.

It may not be amiss to insist for a little on the advantages to science of a great body of men unofficially engaged in scientific research, in writing regarding science, or even in merely turning scientific matter over in their minds. It will not have escaped the notice of those among you who have studied the history of science, that few scientific ideas spring up suddenly without previous trace or history. It is perfectly true that in many cases some mind of unwonted breadth and firmness is required to formulate the new doctrine, and carry it to manifold fruition; but a close examination always shows that the sprite was in the air before the Prospero came to catch him. It is very striking to notice, in the history of Algebra, for instance, long periods in which great improvements were effected in the science, which cannot be traced to any individual, but seem to have been due merely to the working of the minds of scientific men generally upon the matter, one giving it this little turn, another that, in the main always for the better. Like every other thing that has the virtue of truth in it, science grows as it goes, not like the idle gossiping tale by the casual accretion of heterogeneous matter, but by the chemical combination of pure element with pure element in reasonable proportion.

I know of no greater advantage for science than the existence of an army of independent workers sufficiently enlightened for self-criticism, who shall test the results and theories of their day. Great and indispensable as are the uses of professional schools of scientific workmen, they are open to one great and insidious danger. The temptation there to swear by the word of the master is often irresistible. Not to speak of its being often the readiest avenue to fame and profit, it is the perfectly natural consequence of the contact of smaller mind with greater.

There are few things where the want of an enlightened scientific public strikes an expert more than the matter of scientific text-books. If the British public were educated as it ought to be, publishers would not be able to palm off upon them in this guise the ill-paid work of fifth-rate workmen so often as they do; nor would the scientific articles and reviews in popular journals and magazines so often be written by men so palpably ignorant of their subject.

We all have a great respect for the integrity of our British legislators, whatever doubts may haunt us occasionally as to their capacity in practical affairs. The ignorance of many of them regarding some of the most elementary facts that bear on everyday life is very surprising. Scientifically speaking, uneducated themselves, they seem to think that they will catch the echo of a fact or the solution of an arithmetical problem by putting their ears to the sounding-shell of uneducated public opinion. When I observe the process which many such people employ for arriving at what they consider truth, I often think of a story I once heard of an eccentric German student of Chemistry. This gentleman was idle, but, like all his nation, systematic. When he had a precipitate to weigh, instead of resorting to his balance, he would go the round of the laboratory, hold up the test-tube before

each of his fellow-students in turn, and ask him to guess the weight. He then set down all the replies, took the average, and entered the result in his analysis.

I will not take up your time in insisting upon the necessity of the diffusion of science among that large portion of the public who are, or ought to be, applicers of scientific knowledge to practical life. That part of my theme is so obvious, and has been of late so much dwelt upon, that I may pass it by and draw your attention to another place in which the shoe pinches. All of you who have taken any practical interest in the organisation of our educational institutions must be aware of the great difficulty in securing the services of non-professional men of sufficient scientific knowledge to act on School Boards, and undertake the direction of our higher schools. It is no secret among those who carefully watch the course of the times in these matters that our present organisation is utterly insufficient; that it has not solved, and shows every day less likelihood of solving, the problems of higher education. This arises, to a great extent, from the fact that a scientifically educated public of the extent presupposed by the organisation really does not at present exist.

If the existence of a great scientific public be as important as I think I have shown it to be, it must be worth while to devote a few moments to the consideration of the means we adopt to produce it both in the rising and in the risen generation.

It would naturally be expected that we should look carefully to the scientific education of our youth, to see that the best men and the best means that could be had were devoted to it; that we should endeavour to make for them a broad straight road to the newest and best of our scientific ideas; that we should exercise them when young on the best work of the greatest masters; familiarise them early with the great men and the great feats of science, both of the past and of the present; that we should avoid retarding their progress by making the details and illustrations or particular rules and methods ends in themselves. Granting that it is impossible to bring every learner within reach of the fullest scientific knowledge of his time, it would surely be reasonable to take care that the little way we lead him should not be along some devious by-path, but towards some eminence from which he might at least *see* the promised land. The end of all scientific training of the great public I take to be, to enable each member of it to look reason and nature in the face, and judge for himself what, considering the circumstances of his day, may be known, and not be deceived regarding what must to him remain unknown. If this be so, surely the ideal of scientific education which I have sketched is the right one: yet it is most certainly not the ideal of our present system of instruction. To attain conviction on that head it is sufficient to examine the text-books and examination-papers of the day.

Let us confine ourselves for the present to the most elementary of all the exact sciences, viz., geometry and algebra. These two, although among the oldest, are, as Prof. Cayley very justly reminded the Association last year, perhaps the most progressive and promising of all the sciences. Great names of antiquity are associated with them, and in modern times an army of men of genius have aided their advance. Moreover, it cannot be said that this advance concerns the higher parts of these sciences alone. On the contrary, the discoveries of Gauss, Lobatschewsky, and Riemann, and of Poncelet, Möbius, Steiner, Chasles, and Von Standt, in geometry, and the labours of De Morgan, Hamilton, and Grassman, not to mention others, in algebra, have thrown a flood of light on the elements of both these subjects. What traces of all this do we find in our school-books? To be sure *antiquity* is stamped upon our geometry, for we use the text-book of Euclid, which is some two thousand years old; but where can we point to the influence of *modern* progress in our geometrical teaching? For our teaching of algebra, I am afraid, we can claim neither the sanction of antiquity nor the light of modern times. Whether we

look at the elementary, or at what is called the higher teaching of this subject, the result is unsatisfactory. With respect to the former, my experience justifies the criticism of Professor Henrici; and I have no doubt that the remedy he suggests would be effectual. In the higher teaching, which interests me most, I have to complain of the utter neglect of the all-important notion of algebraic form. I found, when I first tried to teach University students co-ordinate geometry, that I had to go back and teach them algebra over again. The fundamental idea of an integral function of a certain degree, having a certain form and so many coefficients, was to them as much an unknown quantity as the proverbial x . I found that their notion of higher algebra was the solution of harder and harder equations. The curious thing is that many examination candidates, who show great facility in reducing exceptional equations to quadratics, appear not to have the remotest idea beforehand of the number of solutions to be expected; and that they will very often produce for you by some fallacious mechanical process a solution which is none at all. In short, the logic of the subject, which, both educationally and scientifically speaking, is the most important part of it, is wholly neglected. The whole training consists in example grinding. What should have been merely the help to attain the end has become the end itself. The result is that algebra, as we teach it, is neither an art nor a science, but an ill-digested farrago of rules, whose object is the solution of examination problems.

The history of this matter of problems, as they are called, illustrates in a singularly instructive way the weak point of our English system of education. They originated, I fancy, in the Cambridge Mathematical Tripos Examination, as a reaction against the abuses of cramming bookwork, and they have spread into almost every branch in science teaching—witness test-tubing in chemistry. At first they may have been a good thing; at all events the tradition at Cambridge was strong in my day, that he that could work the most problems in three or two and a half hours was the ablest man, and, be he ever so ignorant of his subject in its width and breadth, could afford to despise those less gifted with this particular kind of superficial sharpness. But, in the end, came all to the same: we were prepared for problem-working in exactly the same way as for bookwork. We were directed to work through old problem papers, and study the style and peculiarities of the day and of the examiner. The day and the examiner had, in truth, much to do with it, and fashion reigned in problems as in everything else. The only difference I could ever see between problems and bookwork was the greater predominance of the inspiring element of luck in the former. This advantage was more than compensated for by the peculiarly disjointed and, from a truly scientific point of view, worthless nature of the training which was employed to cultivate this species of mental athletics. The result, so far as problems worked in examinations go, is, after all, very miserable, as the reiterated complaints of examiners show; the effect on the examinee is a well-known enervation of mind, an almost incurable superficiality, which might be called Problematic Paralysis—a disease which unfits a man to follow an argument extending beyond the length of a printed octavo page. Another lamentable feature of the matter is that an enormous amount of valuable time is yearly wasted in this country in the production of these scientific trifles. Against the occasional working and propounding of problems as an aid to the comprehension of a subject, and to the starting of a new idea, no one objects, and it has always been noted as a praiseworthy feature of English methods, but the abuse to which it has run is most pernicious.

All men practically engaged in teaching who have learned enough, in spite of the defects of their own early training, to enable them to take a broad view of the matter, are agreed as to the canker which turns everything that is good in our educational practice to evil. It

is the absurd prominence of written competitive examinations that works all this mischief. The end of all education nowadays is to fit the pupil to be examined; the end of every examination not to be an educational instrument, but to be an *examination* which a creditable number of men, however badly taught, shall pass. We reap, but we omit to sow. Consequently our examinations, to be what is called fair—that is, beyond criticism in the newspapers—must contain nothing that is not to be found in the most miserable text-book that anyone can cite bearing on the subject. One of my students, for example, who was plucked in his M.A. examination, and justly so if ever man was, by the unanimous verdict of three examiners, wrote me an indignant letter because he believed, or was assured, that the paper set by the examiners could not have been answered out of Todhunter's Elementary Algebra. I have nothing to say, of course, against that or any other text-book, but who put it into the poor young man's head that the burden lay with me to prove that the examination in question ought to contain nothing but what is to be found in Todhunter's Elementary Algebra? The course of this kind of reasoning is plain enough, and is often developed in the newspapers with that charming simplicity which is peculiar to honest people who are, at the same time, very ignorant and very unthinking. First, it follows that lectures should contain nothing but what is to be found in every text-book; secondly, lectures are therefore useless, since it is all in the text-book; thirdly, the examination should allude to nothing that is not in the text-books, because that would be unfair; fourthly, which is the coach or crammer's deduction, there should be nothing in the text-book that is not likely to be set in the examination. The problem for the writer of a text-book has come now, in fact, to be this—to write a booklet so neatly trimmed and compacted that no coach, on looking through it, can mark a single passage which the candidate for a minimum pass can safely omit. Some of these text-books I have seen, where the scientific matter has been, like the lady's waist in the nursery song, compressed “so gent and sma” that the thickness of it barely, if at all, surpasses what is devoted to the publisher's advertisements. We shall return, I verily believe, to the Compendium of Martianus Capella. The result of all this is that science, in the hands of specialists, soars higher and higher into the light of day, while educators and the educated are left more and more to wander in primeval darkness.

When our system sets such mean ends before the teacher, and encourages such unworthy conceptions of education, is it to be wondered at that the cry arises that pupils degenerate beneath even the contemptible standards of our examinations? These can hardly be made low enough to suit the popular taste. It is no merit of the system we pursue, but due simply to the better among our teachers, men many of them who work for little reward and less praise, that we have not come to a worse pass already. Some even of the much-abused crammers have conceptions of a teacher's duty far higher than the system-mongers of the day, whom it is their special business to out-wit; and it is but fair to allow to such of these also as deserve it part of the credit of stemming the torrent of degeneration. We place our masters in positions such that their very bread depends upon their doing what many of them know and will acknowledge to be *wrong*. Their excuse is, “We do so and so because of the examination.”

The cure for all this evil is simply to give effect to a higher ideal of education in general, and of scientific education in particular. Science cannot live among the people, and scientific education cannot be more than a wordy rehearsal of dead text-books, unless we have living contact with the working minds of living men. It takes the hand of God to make a great mind, but contact with a great mind will make a little mind greater. The most valuable instruction in any art or science is to sit at the feet of a master, and the next best to have con-

tact with another who has himself been so instructed. No agency that I have ever seen at work can compare for efficiency with an intelligent teacher, who has thoroughly made his subject his own. It is by providing such, and not by sowing the dragon's teeth of examinations, that we can hope to raise up an intelligent generation of scientifically educated men, who shall help our race to keep its place in the struggle of nations. In the future we must look more to men and to ideas, and trust less to mere systems. Systems have had their trial. In particular, systems of examination have been tested and found wanting in nearly every civilised country on the face of the earth. Backward as we are here, we are stirring. The University of London, after rendering a great service to the country by forcing the older universities to give up the absurd practice of restricting their advantages to persons professing a particular shade of religious belief, has for many years pursued its career as a mere examining body. It has done so with rare advantages in the way of Government aid, efficient organisation, and an unsurpassed staff of examiners. Yet it has been a failure as an instrument for promoting the higher education—foredoomed to be so, because, as I have said, you must sow before you can reap. At the present time, with great wisdom, the managers of that institution have set about the task of really fitting it out for the great end that it professes to pursue. If they succeed in so doing, they will confer upon the higher education one of the greatest benefits it has yet received. They have an opportunity before them of dethroning the iron tyrant Examination which is truly enviable. This movement is only one of the signs of the times. Among the younger generation I find few or none that have any belief in the “learn when you can and we will examine you” theory; and small wonder, for they have tasted the bitterness of its fruit. *Laissez faire* as a method in the higher education no longer holds its place, except in the minds of inexperienced elderly people, who cling, not unnaturally, to the views and fashions which were young when they were so.

All the same, the task of reformation is not an easy one. Examinations have a strong hold upon us, for various reasons, some good, some bad, but all powerful. In the first place, they came in as an outlet from the system of patronage, which, with many obvious advantages, some of which are now sorely missed, had become unsuited to our social conditions. There is a certain advantage in examinations from the organiser's point of view which anyone who, like myself, has to deal with large quantities of pretty raw material will readily understand. Again, there is an orderly bustle about the system that pleases the business-loving eye of the Briton. Yearly the printed sheets go forth in every corner of the land. The candidates meet and, in the solemn silence of the examination hall, the inspector, the local magnate, or the professor, sits, while for two or three busy hours the pens go scratching over the paper. A feeling of thankfulness comes over the important actor in this well-ordered scene, that the younger generation have such advantages that their fathers never knew. It is only when the answers are dissected in the examiner's study that the rottenness is revealed underlying the fair outward skin. But then the examiner must go by his standards; he must consider what is done elsewhere, and what is to be reasonably expected. Accordingly he takes his report and quickly writes so many per cent passed. Then the chorus of reporting examiners lift up their voices in wonderful concordance; and all, perhaps even the examiners, are comforted. There is something attractive about the whole thing that I can only compare to the pleasure with which one listens to the hum of a busy factory or to the roaring of the forge and ringing of the anvil. But what avails the hum of the factory if the product be shoddy, and what the roar of the forge and the ring of the anvil if the metal we work be base?

In conclusion, let us consider for a moment what might be done for the risen generation, who are too old to go

formally to school, and yet not too old to learn. In their education such bodies as the British Association might be very helpful. Indeed, in the past, the British Association has been very helpful in many ways. It can point to an admirable series of reports on the progress of science, for which everyone who, like myself, has used them, is very grateful. It is much to be desired that these reports should be continued, and extended to many branches of science which they have not yet covered.

The Association has at present, I believe, a committee of inquiry into science-teaching generally. This is typical of a kind of activity which the Association might very profitably extend. This Association, with its long list of members bristling with the names of experts in every science, not drawn from any clique or particular centre, but indiscriminately from the whole land, might take upon itself to look into the question of scientific textbooks and treatises. Even if it did not set up a censorship of the scientific press, which might be an experiment of doubtful wisdom, although some kind of interference seems really wanted now and then, it might set itself to the highly useful work of filling the gaps in our scientific literature. There is nothing from which the English student suffers so much as the want of good scientific manuals. The fact is that the expense of getting up such books in this country is so great, and the demand for them, though steady, yet so limited, that it will not pay publishers to issue them, let alone remunerate authors to write them. In my student days the scarcity was even greater than it is now, and in fact then no one could hope to get even a reasonable acquaintance with the higher branches of exact science unless he had some familiarity with French or German at the very least—a familiarity which was rare among my fellow-students either in England or in Scotland. Might not the British Association now and then request some one fitted for the task to write a treatise on such and such a subject, and offer him reasonable remuneration for the time, labour, and skill required?

Another field in which the Association might profitably extend its labours appears to me to be the furnishing of reports, from time to time, on the teaching of science in other countries, and the drawing up of programmes of instruction for the guidance of schoolmasters and of those who are reading for their own instruction. There is no need to impose these programmes on anyone. I would leave as much freedom to the teacher as I would to the private student. The programme drawn up by the Society for the Improvement of Geometrical Teaching, for example, has been very useful to me as a teacher, although I do not follow it or any other system exclusively. The great thing is not to fall asleep over any programme or system. For the matter of that, Euclid would do very well in the earlier stages of school instruction at least, provided he were modernised, and judiciously discarded at that part of the student's career where a lighter vehicle and more rapid progress becomes necessary. In such programmes as I contemplate the bearing of recent discovery on the elements of the various sciences could be pointed out, and the general public kept in this way from that gross ignorance into which they are at present allowed to fall.

The British Association has of late, I believe, given its attention to the encouragement of local scientific activity. There can be no doubt that much could be done in this way that is not done at present. The concentration of scientific activity in metropolitan centres is beginning to have a depressing effect in Great Britain. This is seen in the singularly unequal way in which Government aid is distributed over the country. Large sums are spent—sometimes we outsiders think not to the best purpose—through certain channels, simply because these channels happen to have a convenient opening in some Government office in London, or in some place in that important city which has easy access to the ruling powers; while applications on behalf of other objects not less worthy are met with a refusal which is sometimes barely courteous. The result is that local effort languishes, and men of energy,

finding that nothing can be done apart from certain centres, naturally gravitate thither, leaving provincial desolation to become more desolate.

I think our great scientific societies—the Royal Societies of London and Edinburgh and the Royal Irish Academy—might do more than they do at present to prevent this languishing of local science, which is so prejudicial to the growth of a scientific public. Besides their all-important publishing function, these bodies have for a considerable time back been constituted into a species of examining and degree-conferring bodies for grown-up men. That is to say, their membership has been conferred upon a principle of *exclusion*. Instead of anyone being *admitted* who is willing to do his best, by paying his subscription or otherwise, to advance science, everyone is *excluded* who does not come up to the standard of a certain examining body. So far is this carried in the case of the Royal Society of London, that there is an actual competitive examination, on the result of which a certain number of successful candidates are annually chosen. Now, against this proceeding by itself I have nothing to say, except that it appears to belong to the pupillary age both of men and nations. It is not the honouring of the select few that I think evil, but the exclusion of the unhonoured many. The original intention in founding these societies was to promote the advancement of science. How that is done by excluding anyone, be it the least gifted among us, who is honestly willing to contribute his mite towards the great end, fairly passes my comprehension. If it is thought necessary, for the proper cultivation of the scientific spirit among us, that the degree-conferring function should be continued, let there by all means be an inner court of the temple, a place for titular immortals; but let there be also a court of the Gentiles, where those whose fate or whose choice it is to serve science unadorned may find a modest reception. I believe that the adoption of this suggestion would enormously extend the usefulness of our great scientific societies, and give to their voice a weight which it never had before. At all events, if the trammels of tradition or some better reason with which I am unacquainted, should prevent them from broadening their basis in the way I indicate, nothing prevents the British Association, with its more liberal constitution, from considering what may be done for the scientific plebeian.

There is one other function of the British Association in connection with which I wish to venture another suggestion. During the annual meeting, scientific men have an opportunity of making each other's acquaintance. Great men exchange ideas with great men; and, most important of all, young and little men have a chance, rarely otherwise afforded, of taking a nearer view of the great. What I would suggest for consideration is, whether it might not be possible to form an organisation which would in a certain sense carry this advantage through the whole year. I have already alluded more than once to the difficulties that the scientific public—and here I include professional men generally, in fact all but the leaders of science—have in keeping pace with recent advances. Would it not be possible to have an arrangement enabling at least every large centre of the higher education to have periodically the benefit of communion with and instruction from the high priests of the various branches of science? How glad we, the teachers of science in Edinburgh for example, would be to have a course of lectures once every three or four years from Professors Cayley, Sylvester, Stokes, Adams, Lord Rayleigh. In this way effect would be given to the principle which cannot be too much insisted upon, that the power of the spoken word far exceeds that of the written letter. Not only should we learn from the mouths of the prophets themselves the highest truths of science, but the present generation would thus come to know face to face, as living men, those whose work will be the glory of their time and a light for future ages. From the want of a proper circulating medium, the influence of great scientific men very often does not develop until they and the secrets of their

insight have gone from among us. The object of what I propose is to make these men more of a living power in their own lifetime.

ON THE INFLUENCE OF TEMPERATURE ON THE HEAT OF DISSOLUTION OF SALTS IN WATER.*

By WILLIAM A. TILDEN, D.Sc. Lond., F.R.S.,
Professor of Chemistry in the Mason College, Birmingham.

(Continued from p. 112).

For the sake of comparison sulphate of potassium, which always crystallises without water, was taken with the following results.

Potassium Sulphate, K_2SO_4 , in 100 molecules of Water, or 174 parts in 1800 parts by weight.

Weight of salt used 7.733 grm.

Weight of water used 80.00 "

Specific heat of solution $K_2SO_4.100H_2O=0.8965$.

No. of expt.	Water equiv. calorim., &c.	Temperature.		Correc- tion.	Total fall.	Molecular heat of dissolu- tion.
		Before solution.	After solution.			
43	110.4	15.23	13.015	-0.004	2.211	5494
44	110.3	15.02	13.02	+0.03	2.03	5037
45	110.4	15.105	13.050	+0.100	2.155	5348
46	110.3	15.70	13.52	+0.03	2.21	5472
47	109.4	23.665	21.560	-0.006	2.099	5166
48	109.4	23.90	21.78	0	2.12	5219
49	109.3	36.86	34.93	-0.006	1.924	4720
50	109.4	37.60	35.53	-0.01	2.06	5073
51	109.3	36.99	35.00	-0.008	1.982	4865
52	109.3	45.00	43.13	+0.075	1.945	4782
53	109.3	45.06	43.20	+0.046	1.906	4678

Approximate temperature.

Mean heat of dissolution.

15°

-5338

24°

-5192

37°

-4886

45°

-4730

Take Q_t at 15° = -5338

$C=34.1$ (Kopp) and $18n+K=1781$ (Marignac).

$T=45°$.

$Q_r = -3745$.

Observed, -4730. Difference, 985.

In the solution of anhydrous carbonate and sulphate of sodium in water, evolution of heat occurs, and the amount of heat evolved increases with the temperature, but is not so great as would be inferred from the application of Person's formula. On the other hand, sulphate of potassium the solution of which is attended by absorption of heat, gives a gradually diminishing absorption as the temperature is raised, but the observed absorption is greater at the higher temperature than the calculated amount. That is to say, in all these cases, whether the act of solution is attended by rise or fall of temperature, there is a consumption of energy corresponding to an absorption of heat, which is not accounted for by the difference between the specific heats of the materials, and of the solution which results from their union.

From the connection already established between fusibility and solubility, and from *a priori* considerations, it seemed probable that the thermal change attending the solution of a solid must vary according as by raising the temperature the cohesion of the solid is diminished, or by lowering the temperature the cohesion is increased. For if a salt dissolves in water with absorption of heat, this absorption will be less at higher temperatures when the cohesion of the solid has been reduced, and therefore the

energy required for its liquefaction by the solvent also lessened. On the other hand, if a salt dissolves with evolution of heat, the heat evolved must be greater at higher temperatures for the same reason.

Some very fusible salts were therefore taken in order to ascertain whether the difference between the observed and calculated heats of solution was notably greater or less than the difference observed in the case of the sodium carbonate and sulphate and potassium sulphates.

Potassium Nitrate, KNO_3 , in 100 molecules of Water, or 101.1 parts in 1800 parts by weight.

Weight of salt used 4.774 grms.

Weight of water used 85 "

Specific heat of solution $KNO_3.100H_2O=0.942$

No. of expt.	Water equiv. calorim., &c.	Temperature.		Correc- tion.	Total fall.	Molecular heat of dissolu- tion.
		Before solution.	After solution.			
54	116.8	15.55	12.30	0	3.25	8028
55	116.7	15.50	12.30	0	3.20	7906
56	116.7	34.42	31.30	0	3.12	7703
57	116.7	34.61	31.39	-0.006	3.214	7926
58	116.7	52.72	49.60	-0.015	3.105	7662
59	116.7	53.88	50.87	-0.004	3.006	7421

Mean.

Approximate temperature.

Heat of dissolution.

15°

-7967

34°

-7814

53°

-7541

From the values $C=23.2$ (Kopp), $18n+K=1791$ (Thomsen), and $Q_t = -7967$ at 15°, $Q_r = -6751$ when $T=53°$.

Sodium Nitrate, $NaNO_3$, in 100 molecules of Water, or 85 parts in 1830 parts by weight.

Weight of salt used 4.013 grms.

Weight of water used 85.0 "

Specific heat of solution $NaNO_3.100H_2O=0.950$.

No. of expt.	Water equiv. calorim., &c.	Temperature.		Correc- tion.	Total fall.	Molecular heat of dissolu- tion.
		Before solution.	After solution.			
60	116.8	16.30	14.36	-0.003	1.937	4776
61	116.8	16.05	14.15	+0.040	1.940	4796
62	116.8	54.42	52.67	-0.004	1.746	4306
63	116.8	54.80	53.09	-0.002	1.708	4204

Mean.

Temperature.

Heat of dissolution.

16°

-4786

54°

-4255

Calculated from the values $C=21.8$ (Kopp), $18nK=1791$ (Thomsen), and taking $Q_t = -4786$ at 16°, $Q_r = -3616$ when T is 54°.

Experiments published in 1873 by Winkelmann,* on the solution of the potassium, sodium, and ammonium chlorides and nitrates in water at different temperatures lead to similar conclusions. Thus, taking Winkelmann's figure representing the heat of dissolution of nitrate of sodium, 1 grm. of salt in 20.80 grms. of water, which is very nearly 1 mol. of salt to 100 mols. of water—

At 2—3° gives as a mean -60.30 cal.

At 50—51° " " " -48.70 "

For a molecule of salt, or 85 grms.—

$60.3 \times 85 = 5125.5$

$48.7 \times 85 = 5139.5$

* Pogg. Ann., cxlix., 1. Winkelmann's experiments were directed towards the object of determining the specific heat of the solutions of these six salts. One difficulty in the way of the general application of this method is the uncertainty attaching to the specific heats of the salts in the solid state, by reason of the variability of their properties according to the manner in which they have been prepared.

By the formula—

$$Q_T = Q_t + [(18n + C) - (18n + K)](T - t),$$

and using the values already given for sodium nitrate,

$$Q_T = -3646.6,$$

and this is very nearly identical with the number calculated from my own experiment at 16°.

I have made a few determinations of heat of solution of the crystallised sulphate and carbonate of sodium. Whilst these salts dissolve at common temperatures, with great absorption of heat, the absorption at the melting-point is very feeble, and at a few degrees higher is changed into evolution of heat. This last-named effect is probably due to the fact that when heated beyond their melting-point, 34° (*circa.*), these salts are partly deposited in a solid dehydrated state.

Sodium Sulphate, $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$, in 190 molecules of Water, or 322 parts by weight in 3420 parts of Water.

Weight of salt used 8.05 grms.

Weight of water used 85.5 "

Specific heat of solution $\text{Na}_2\text{SO}_4 \cdot 200\text{H}_2\text{O} = 0.955$.

Water equiv. calorm., &c.	Temperature.		Correc- tion.	Total change.	Molecular heat of dissolu- tion.	Mean.
	Before solution.	After solution.				
121.4	16.390	12.945	+0.255	-3.700	-17939	-18035*
121.1	16.250	12.800	+0.300	-3.750	-18131	
121.4	34.180	34.040	-0.004	-0.136	- 660	- 660
121.3	48.150	48.200	-0.004	+0.046	+ 223	+ 223

Sodium Carbonate, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$, in 180 molecules, or 286 parts in 3240 parts by weight of Water.

Weight of salt used 7.150 grms.

Weight of water used 81.00 "

Specific heat of solution $\text{Na}_2\text{CO}_3 \cdot 190\text{H}_2\text{O} = 0.950$ approximately.

Water equiv. calorm., &c.	Temperature.		Correc- tion.	Total change.	Molecular heat of dissolu- tion.	Mean.
	Before solution.	After solution.				
117.3	15.025	12.020	+0.1312	-3.1362	-14714	-14714
116.1	34.820	34.500	-0.014	0.306	- 1405	- 1288
116.1	34.300	34.050	+0.005	0.255	- 1171	
116.1	39.390	39.300	+0.0075	0.0975	- 446	- 446
116.1	47.710	47.690	0	0.020	- 91	- 91
116.1	48.040	48.100	0	+0.062	+ 275	+ 311
116.1	48.230	48.300	-0.005	0.075	+ 347	

The very rapid decline in the heat absorption attending the solution of these two salts cannot be accounted for by Person's principle, whatever value be considered probable for the specific heat of the solid salt.

The process of dissolving a solid in a liquid must be considered as involving several distinct operations. Person seems to have been the first to point out that the change of state from solid to liquid must be distinguished from the intermixture of the liquefied solid with the water. Both these acts must be attended by heat-absorption. The dilution of watery solutions has been shown, especially by the researches of Thomsen, to be attended very generally by absorption of heat, notwithstanding that in most cases it is accompanied by contraction of volume, a process which must have an opposite effect.

In the solution of many anhydrous and even hydrated salts, we must believe, from the very energetic thermal change observed, that the salt enters into chemical union with a portion of the liquid. The extent to which this combination occurs will be greatly influenced by the temperature at which the experiment is made, and at sufficiently elevated temperatures it must be believed to entirely annul, whilst on the other hand, as the temperature is raised, chemical action, resulting in double

decomposition between the water and constituents of the salt, becomes apparent. This action, which is manifested in the case of the salts of the heavy metals by the production of insoluble oxides, hydroxides, or basic salts, cannot be supposed to be altogether without effect in the case of the salts of the alkali metals such as I have been examining, and I incline strongly to the belief that a part of the difference which I have pointed out between the observed heat of solution and the same calculated according to Person's formula, is due to this decomposing action of the water.

It is manifest that no theory of solution can be accepted which does not take cognisance of all these facts.

In conclusion, I desire to acknowledge the intelligent assistance I have received in the conduct of these experiments from Mr. Harold P. White.

NOTE ON THE BEHAVIOUR OF NITRATES IN KJELDAHL'S PROCESS FOR THE DETERMINATION OF NITROGEN.

By R. WARINGTON,

THE process devised by Kjeldahl for the determination of nitrogen in organic substances (*Zeit. f. anal. Chem.*, 1883, 366) has met with considerable acceptance, from the speed with which the operation can be conducted and the accuracy of the results. It consists in heating the organic substance with concentrated sulphuric acid in a small flask at a temperature somewhat below its boiling-point, and when the oxidation is nearly completed adding finely-powdered potassium permanganate till a green colour remains constant. The whole of the organic nitrogen is thus converted into ammonia. The solution is then diluted, treated with excess of sodium hydrate in a suitable apparatus, the ammonia distilled off, collected in standard acid, and its quantity determined.

Wishing to employ this method for the analysis of organic substances containing nitrates, I have been led to make a few experiments on the influence of nitrates in the reaction. The experiments are as yet incomplete, but as a paper on this subject has been announced in the last number of the *Annales agronomiques* as shortly to be published, I am induced to communicate the facts I have at present ascertained. It is, of course, obvious that unless the method can be employed for the analysis of substances containing nitrates its usefulness will be rather seriously curtailed, as (with the exception of ripe seeds) nitrates generally occur in vegetable produce.

The facts already known seemed to point out two opposite directions in which nitrates might be expected to act. A well known method of removing nitric acid from oil of vitriol is to add a few crystals of ammonium sulphate to the acid, and then heat to the boiling-point; the nitric acid is by this means entirely expelled. If this removal of nitric acid be due to the decomposition of ammonium nitrate, it would of course follow that the heating of sulphuric acid containing ammonia and nitrates would result in a loss of ammonia. On the other hand, Kjeldahl has shown that when nitrates are heated with oil of vitriol in the presence of organic matter, a considerable part of the nitric acid is reduced to ammonia; the presence of nitrates would thus under these circumstances determine an excess in the amount of organic nitrogen found. The quantitative experiments I have made confirm both of these reactions.

A unit of dry ammonium sulphate was taken, yielding, after treatment with oil of vitriol, 0.05142 grm. of nitrogen (mean of three experiments). With this unit of ammonium sulphate, and 0.15 grm. of potassium nitrate, both dissolved in the oil of vitriol, the ammonia found at the conclusion of the process was, in four experiments, 0.03249, 0.03093, 0.03054, and 0.03249 grm. of nitrogen. The loss of ammonia

* Thomsen's figure at 18° is -18509.

was thus very considerable; it was apparently greatest when the mixture was quickly heated, and least when heat was very gradually applied. The loss of ammonia is approximately equal to the quantity of nitrogen added as potassium nitrate; it is most probable, therefore, that ammonium nitrate had been formed, and subsequently destroyed.

The very considerable loss of ammonia resulting from the heating of dry ammonium sulphate and potassium nitrate dissolved in concentrated sulphuric acid may be entirely obviated if a little water is present in the mixture. Under these circumstances the nitric acid volatilises with the water during the early stages of heating, and the ammonia remains unaffected. Four experiments made with the same quantities of ammonium salt and nitrate as before, with 10 c.c. of oil of vitriol, 10 to 12 c.c. of water being present at the commencement of the heating, gave respectively 0.05015, 0.05157, 0.05135, and 0.05096 grm. of nitrogen,—quantities nearly agreeing with that already mentioned as proper to the ammonium sulphate taken. The best results were obtained when the solution was kept cool during the addition of the sulphuric acid, and the subsequent heat was gradually applied.

The results as yet given refer to the reaction in the absence of organic matter. When the same quantities of ammonium sulphate and nitre were heated with oil of vitriol and 0.5 grm. of starch, no water being present, 0.06236 grm. of nitrogen was obtained. A considerable part of the nitric acid has thus been converted into ammonia. Kjeldahl, using mixtures of nitre and sugar, found that 60 to 80 per cent of the nitric nitrogen was converted into ammonia during the heating with sulphuric acid.

It is quite obvious from these results, that for the accurate use of Kjeldahl's method as a means of determining organic nitrogen it will be necessary either to remove the nitrates from the substance before heating with concentrated sulphuric acid, or else to entirely convert the nitrates into ammonia by some preliminary treatment, and finally to deduct from the total nitrogen found that due to the nitrates, which in this case must be separately determined. My own experiments have been directed to establish a method of the first kind, as being the simplest that could be adopted.

In the following experiments fixed quantities of ammonium sulphate and bean-meal were uniformly employed; together they yielded 0.01064 grm. of nitrogen, when heated with sulphuric acid, and oxidised with permanganate. When to this material 0.07 grm. of potassium nitrate was added, water being absent, the nitrogen found became 0.01519 grm., a large part of the nitric acid being, as before, converted into ammonia.

The first scheme tried for the removal of nitric acid simply consisted in the addition of a small quantity of water. This plan, as already mentioned, had been found successful in the absence of organic matter. As the presence of water would considerably interfere with the oxidising action of the oil of vitriol,* the substance taken was first heated with a small quantity of water and sulphuric acid, the heat being continued till the water had apparently been expelled; the principal amount of oil of vitriol was then added, and the oxidising process commenced.

This mode of proceeding did not prove satisfactory, the use of water always resulting in a loss of nitrogen. When the preliminary heating was made with 2 c.c. of water and 1 c.c. of oil of vitriol, the nitrogen found was 0.00839 grm. When 1 c.c. of water and 1 c.c. of oil of vitriol were used, 0.00879 and 0.00941 grm. of nitrogen were found. This loss of nitrogen was probably due to the action of nitrous acid on ammonia or amides. The result is different from that of the earlier experiments made with mixed nitrates and ammonium salts, as in that case only nitric acid was present. In the present experi-

ments the reduction of the nitric acid by the organic matter was quite apparent, red fumes being produced. Thus in the presence of organic matter, the action of nitrates, in the absence of water, resulted in a large gain of nitrogen, while in the presence of even a small quantity of water a loss of nitrogen was determined.

In the next experiments it was sought to remove the nitrates by means of the well-known reaction with ferrous sulphate.

When no water was present it was found that powdered ferrous sulphate was practically without effect. A mixture of the same quantities of ammonium sulphate and bean-meal mentioned above, with 0.07 grm. of nitre, and 0.75 grm. of ferrous sulphate, yielded 0.01491 grm. of nitrogen when heated with oil of vitriol. The nitric acid was thus converted into ammonia in place of being expelled. Qualitative experiments also showed that ferrous sulphate crystals were almost without action on a solution of potassium nitrate in concentrated sulphuric acid.

Trials made in the presence of water proved unsatisfactory. A preliminary heating of the materials last named with 1 c.c. of water and 2 c.c. of concentrated sulphuric acid, gave 0.0116 grm. of nitrogen for the final result, a quantity still in excess of the truth. Probably better results would have been obtained by using more water, but as the treatment was found very tedious, it was resolved to try a preliminary heating with hydrochloric instead of sulphuric acid.

As the hydrochloric acid and ferrous sulphate might possibly contain traces of ammonia, the experiments were made in duplicate. The ammonium sulphate and bean meal, with 0.07 grm. of nitre, and 0.75 grm. of ferrous sulphate, were heated with 2 c.c. of concentrated hydrochloric acid, and the contents of the flask allowed to become dry; 10 c.c. of concentrated sulphuric acid were then added, and the experiment continued in the usual manner. A duplicate experiment was made with the same materials, the nitre being omitted. The results obtained were as follows:—With nitre, 0.01076 grm. nitrogen; without nitre, 0.01075 grm. In two other experiments the result was not quite so good, the result being, with nitre, 0.01064, without nitre, 0.01046 grm. of nitrogen.

A preliminary heating of the organic substance containing nitrates with an excess of ferrous sulphate and strong hydrochloric acid thus appears to answer very fairly for the expulsion of nitric nitrogen. After drying, the mass may then be treated with concentrated sulphuric acid, and the rest of Kjeldahl's process proceeded with.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from page 110.)

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
- || Following a date signifies publication discontinued.

Followed by :

- [b] Magazin für die neuesten Erfahrungen, Entdeckungen und Berichtigungen im Gebiete der Pharmacie, mit Hinsicht auf physiologische Prüfung und praktisch bewährte Anwendbarkeit der Heilmittel, vorzüglich neuentdeckter Arzneistoffe in der Therapie. Herausgegeben von G. F. Hänle [from 1829, by P. L. Geiger]. 36 vols., 8vo. Carlsruhe, 1823-'31.||

From 1829-'31 also under the title: Magazin für Pharmacie und Experimental-Kritik. United in 1832 with Archiv des Apotheker-Vereins im nördlichen Deutschland, forming the Annalen der Pharmacie, &c.

* The addition of sulphuric or phosphoric anhydride to the oil of vitriol is strongly recommended as a means of facilitating the oxidation of organic matter.

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

OBSERVATIONS ET MÉMOIRES SUR LA PHYSIQUE [etc.].
See Introduction aux observations sur la physique.

OPWYRDA, R. J.
See Toegepaste Scheikunde.

135. OROSI (L'). Bollettino di chimica, farmacia e scienze affini. Pubblicato per cura dell'associazione chimico-farmaceutica fiorentina. 7 vols., 8vo. Firenze, 1878-'84+

PARIS, SOCIÉTÉ CHIMIQUE DE.
See Répertoire de chimie pure et appliquée.

PATERNO, M.
See Gazzetta chimica italiana.

136. PENNY MECHANIC AND CHEMIST. 8 vols. London, 1836-'42.

137. PHARMACEUTICAL (THE) TIMES. A journal of chemistry applied to the arts, agriculture, and manufactures. 3 vols., 4to. London, 1847, '48.

Continued under the title:

- [a] Chemical (The) Times and Journal of Pharmacy, Manufactures [etc.]. [Edited by G. M. Mowbray.] 2 vols., 4to. London, 1848, '49.

138. PHARMACEUTISCHES CENTRALBLATT. [Edited from 1830-'38 anonymously; from 1840-'44, by A. Weinlig; 1845-'47 by R. Buchheim; 1848, '49, by W. Knop.] 20 vols., 8vo. Leipzig, 1830-'49.

Continued under the title:

- [a] Chemisch-pharmaceutisches Centralblatt. Redacteur: W. Knop. 5 vols. (XXI.-XXV.), 8vo. Leipzig, 1850-'55.

Continued under the title:

- [b] Chemisches Centralblatt. Repertorium für reine, pharmaceutische, physiologische und technische Chemie. Redaction: W. Knop. [From 1862, Red.: Rud. Arendt.] Neue Folge. 14 vols. (XXVI.-XXXIX.), 8vo. Leipzig, 1856-'69.
Dritte Folge. Redigirt von Rudolph Arendt. 15 vols. (XL.-LIV.), 8vo. Leipzig, 1870-'84+
General-Register zum chemischen Centralblatt, III. Folge, Jahrgang I.-XII. 1870-'81. Redigirt von Rud. Arendt. 1 vol., 8vo. Leipzig, 1882, '83.

139. PHARMACIST (THE) AND CHEMICAL RECORD. A monthly journal devoted to pharmacy, chemistry, and the collateral sciences. Published by the Chicago College of Pharmacy. Editor, N. Gray Bartlett; associate editor, Albert E. Ebert. [From vol. III., edited by E. H. Sargent.] 5 vols., 8vo. Chicago, 1868-'72.

Continued under the title:

- [a] Pharmacist (The). 6 vols. (VI.-IX.). Chicago, 1873-'78.

Continued under the title:

- [b] Pharmacist (The) and Chemist. Published by the Chicago College of Pharmacy. [Conducted by Robert H. Cowdrey.] 6 vols. (XII.-XVII.). Chicago, 1879-'84+

PHILADELPHIA.

See Memoirs of the Columbian Chemical Society.

(To be continued).

South London School of Pharmacy.—The following prizes were presented to the successful competitors on Saturday, September 19th, 1885:—Senior Chemistry—Medal: Francis W. Taylor; Certificate, John B. Nichols. Junior Chemistry—Medal: Andrew Craig; Certificate, Alfred L. Wood. Botany—Medal: John B. Nichols; Certificate, Ernest L. Ralling. Materia Medica—Medal: John Tirrell; Certificate, J. Burgess. Pharmacy and Practical Dispensing—Medal: Robert Pyle; Certificate, John W. Carr. Extra Certificates of Merit to Messrs. Jackson, Lewis, Minter, Moore, and G. H. Taylor.

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Prof. CHAS. E. MUNROE, U.S.N.A.

(Continued from p. 116.)

SPECIAL Report No. 55 is by Colonel Majendie and Captain Cundill, and describes the "Circumstances attending Two Explosions which occurred on the Underground Railway, London, on the 30th October, 1883." These explosions took place near the Praed Street Station and at a point between the Charing Cross and Westminster Stations. The first explosion occurred in a tunnel, about 138 feet distant from the station, as the 7.52 p.m. train was passing. The damage in the tunnel consisted in a vertical crater in the wall about 12 inches high, 13 inches wide, and 4 to 6 inches deep. Immediately below this crater, and extending about 15 inches along the wall, was a horizontal crater about 6 inches deep, partly in the ballast and partly in the brick footing of the tunnel. The flinty ballast in this crater was considerably splintered, and the brick footing pulverised. A 2-inch gas-pipe ran along the wall at a height of 10 inches; a length of this, measuring 14 feet, was blown away, one end being much torn and twisted, and the whole piece bent into the form of a bow. At a distance of 15 inches from the wall, and parallel with it, was an iron switch-rod consisting of a 1½ inch gas-pipe supported on iron rollers at the level of the rails, from which it was distant 2 feet 9 inches, the rollers being fixed on a wooden plank laid on the ballast. The board had about 4 feet of its length blown to splinters, and a large piece thrown upon the rail, and some of the wheels of the train passed over it. A length of the switch-rod, measuring about 2 feet, and corresponding exactly with the portion of the gas-pipe which sustained the maximum injury, was blown out, the central part of this detached portion being split up and torn. This piece of switch-rod also bore marks of the wheels upon it. A telegraph cable running along the wall at the height of 8½ feet was cut by the explosion. The walls of the tunnel were scored somewhat by the sharp *débris* blown against them, and the end of a sleeper opposite the crater, but partially protected by the ballast in which it was imbedded, had a number of pieces of splintered stone driven deeply into it. The rails were entirely uninjured.

The injury to the passing train was confined principally to the last two carriages of the six composing the train. In these the greater part of the glass was broken into small fragments, panels and partitions were shattered, the roofs and floors disturbed, the footboards broken, and the carriages seemed to be completely wrecked, yet no part of the framing or running gear was injured.

The gas throughout the train was extinguished, yet the apparatus was found to be uninjured. It is interesting to note that the injury to the train was not confined to the side on which the explosion took place, but extended also to the opposite side, and in the case of one carriage the damage was most marked on that side; sixty-two persons were injured by cuts and contusions from the pieces of glass and *débris*, and in one or two cases by fracture of the drum of the ear and by severe shocks. Five of the injured were confined in the hospital for a considerable time. The breaking of the glass and putting out of the gas occurred on the surface at the openings of the tunnel for a distance of 350 feet.

The second explosion, which occurred almost simultaneously with the first, took place at a point 24 yards from Charing Cross and 488 yards from Westminster. As it occurred opposite a bay, the only damage done was the breaking of glass and the extinction of gas in both stations; the injuring of the telegraph and telephone

* From the *Proceedings of the U.S. Naval Institute*.

As it is proposed to continue these notes from time to time, authors, publishers, and manufacturers will do the writer a favour by sending him copies of their papers, publications, trade circulars, or expert testimony in infringement cases.

wires for about 60 yards; the formation of a crater in the ballast, measuring 3×4 inches wide and 1 inch deep; and the "patting" of the walls of the tunnel on the side of the explosion for some little distance to the right and left of the crater, and on the opposite side for a somewhat greater distance. The rails were entirely uninjured, but the ends of the sleepers near to which the explosion occurred sustained some injury.

Three hypotheses were suggested as to the nature of the explosive, viz., coal-gas, gunpowder, and dynamite. The fact that all the gas apparatus was found intact disposed of the first; the absence of all residue and the extremely local and brusque action of the explosion testified unmistakably to the use of an agent possessing greater detonative energy than gunpowder, while these properties are characteristic of dynamite. The finding a piece of Bickford safety fuse and fragments of copper, presumably from a detonator, strengthened this belief. Accepting this theory, experiments were made by Colonel Majendie, together with Prof. Abel and Dr. Dupré, to determine the amount of dynamite necessary to produce the observed effects, the switch-rod and gas-pipe from the Praed Street tunnel being used in similar positions to the charge which they bore there, and it was found that 2 lbs. of ordinary dynamite would be sufficient, if properly detonated. The circumstances surrounding the explosions, however, indicated that a larger amount—probably 5 lbs.—had been used, but that a portion had burned without explosion.

The explosion was probably induced by the use of a fuse of such a length as would burn for the desired time. This was then attached to a detonating cap, and the latter inserted in a zinc case containing the dynamite. The assassin then boarded a passing train, and lighting the fuse threw the contrivance from the window, the fuse being timed to explode the cartridge under the train following. In the case of the Praed Street train the explosion was premature, and occurred under the train in which the assassin was. In the second case the explosion occurred at the time designed, but the train for which it was intended was late; in one minute more the train would have reached the spot.

In manufacturing processes in chemistry considerable loss ensues where the process must be arrested from time to time in order to permit of the charging or discharging of the apparatus; hence efforts are constantly being made to devise apparatuses and methods by which the processes may go on continuously. Such a method has now been invented by W. N. Hill, for the manufacture of nitro-glycerin, and for which U. S. Letters Patent No. 262,769 have been issued. Without the aid of drawings it is difficult to describe the apparatus, but it will suffice to say that it consists of two converters, with acid and glycerin tanks attached, a separator and receivers for the nitro-glycerin and spent acids, all connected by tubes so that the contents of one may flow to the other. The use of two converters admits of the conversion taking place by successive stages, while weaker acid may be used in the earlier stage. The separator is so arranged as to help materially in controlling the speed of the operation, while by the position of the receivers relatively to the separator we can easily see how the process is progressing at any given time. Of course proper arrangements are made for promoting the mixing of the ingredients and cooling of the mixtures.

Mr. George M'Roberts, F.C.S., has favoured us with a copy of an excellent resumé presented by him to the Philosophical Society of Glasgow, April 25, 1883, under the title of "Notes on Nitro-glycerin, Dynamite, and Blasting Gelatin," from which we learn that at low temperatures blasting gelatin freezes into a hard whitish solid of crystalline structure; but the exact temperature at which freezing takes place has not been ascertained, as cartridges are sometimes found to resist freezing for 24 hours, although kept during that time in a mixture of ice and salt. Other cartridges are found to freeze readily at

about 30° to 40° F. Frozen gelatin is in some respects more easily exploded than unfrozen gelatin. A rifle bullet can be fired through any number of unfrozen gelatin cartridges without exploding them, but when a shot is fired similarly through frozen cartridges they never failed to go off. In this respect blasting gelatin behaves exactly the reverse of dynamite. The transmission of detonation through blasting gelatin when unfrozen is much more slow than through either nitro-glycerin or dynamite, but when the cartridges are frozen the detonation appears to be quite as rapid as in dynamite. It has been lately sought to use blasting gelatin in shells, but the material in its present form does not appear to be well adapted to such a purpose. In order to render it less sensitive, so that the shell might be fired from the gun without risk of exploding the charge, the gelatin had incorporated with it about 3 to 5 per cent of camphor. The camphor had the effect of rendering the gelatin so insensible to shock that even the blow of the shell against an iron target failed to set it off, and the gelatin was gathered up in bits all around the target. The effect of increasing the proportion of nitro-cotton in gelatin, and diminishing that of nitro-glycerin, is to lessen its sensibility to explosion; and gelatin made tough with 9 or 10 per cent of nitro-cotton cannot be got to explode with a detonator containing 12 grains of fulminate of mercury and chlorate of potassium. On the other hand, when gelatin is made of a viscid consistency—such that a cartridge, when deprived of its wrapper and allowed to stand on a porcelain plate begins to spread itself out—the ordinary detonator in use for exploding dynamite never fails to explode it.

When 10 grms. of explosive were fired, with a fuse and detonator, in a pendulum mortar, the following results were obtained:—

	Foot-pounds.
Blasting gelatin, consisting of 93 per cent of nitro-glycerin and 7 per cent of nitro-cotton	1400
Nitro-glycerin	1270
No. 1 Dynamite	900
No. 2 Dynamite consisting of 18 parts of nitro-glycerin, 71 parts of nitrate of potash, 10 parts of charcoal, and one part of paraffin	531
Westquarter factory mixture for detonators, consisting of 70 parts fulminate of mercury and 30 parts KClO ₃	481
Gun-cotton*	462
Fulminate of mercury	307
Curtis and Harvey's extra strong gunpowder ..	272

The method of testing explosives described above is applicable only to those that detonate, or, in other words, to those explosives whose conversion into gas is practically instantaneous. If the explosive is a slow one, such as gunpowder, the projectile may have escaped before the whole charge is consumed; but with detonating mixtures the explosion is so rapid that there can be no doubt that the conversion into gas is complete, even before the projectile has begun to move. The chronoscope of Captain Noble showed that explosion is transmitted through trains of dynamite at the rate of 20,000 to 24,000 feet per second. At this rate the explosion of a cartridge a foot long must only occupy the 24,000th part of a second. A ton of dynamite cartridges of the usual size, about $\frac{3}{8}$ " diameter, laid end to end in a line would stretch a mile, and the whole train could be exploded in the one-fourth part of a second by firing a cartridge at either of the ends. If fired in the middle of the line the explosion would be transmitted both ways, and would occupy only the eighth part of a second. The facility with which dynamite can be fired in trains offers great advantage in many engineering operations, such as where it is required to blow down an arch or a wall. It is enough to lay a train of cartridges along the crown of the arch, or along the bottom of the

* The reason, no doubt, why the gun-cotton shows so poorly in this table is that its explosion in the mortar was imperfect.

wall, and explode one cartridge in the usual way with a detonator. The whole train goes off instantly. The enormous velocity with which dynamite explodes explains the great violence of its action, and the tremendous local rupturing effects of even small quantities of it exploded in the open, and without being enclosed in a case of any kind. The detonation of a cartridge in the 24,000th part of a second must produce an enormous instantaneous pressure on the spot on which it explodes. For such a sudden explosion the pressure of the atmosphere itself is sufficient tamping.

The increase in the demand among miners for strong explosives is very remarkable. Since 1867 the annual sales of dynamite from the factories with which Mr. Nobel is associated have been as follows:—

In 1867, 11 tons.	In 1875, 3500 tons.
1868, 78	1876, 4300
1869, 184	1877, 5500
1870, 424	1878, 6200
1871, 785	1879, 7000
1872, 1350	1880, 7500
1873, 2050	1881, 8500
1874, 3120	1882, 9500

The last two years have been estimated, as there are no precise figures to go by. The sale of such a large quantity of explosives indicates a considerable amount of mining activity. Besides the factories with which Mr. Nobel is connected, numerous others have sprung into existence, notably in Germany and in America. In Austria dynamite is no longer manufactured, as there is no demand for it, its place having been taken by blasting gelatin.

It is unfortunate that in Great Britain the manufacture and sale of explosives is hampered to a hurtful degree by legislative restrictions. Some restriction is no doubt necessary, but in this country restriction at times amounts to prohibition, if a new explosive is to be introduced. As the law now stands, if a manufacturer discovers a new explosive or a new explosive mixture, he cannot make working trials of it without the consent of the Home Office, and without having submitted samples to the Home Office Chemist, to whom, as a matter of course, a fee must be paid. This regulation must interfere with the introduction of a new invention, because no man will care to pay fees for the examination of an explosive which, when it comes to be tried, may not take with the public after all. Abroad, although there are restrictions affecting explosives, there are no such onerous impediments as here; hence foreign chemists and manufacturers have an advantage in that respect.

(To be continued).

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 8, Aug. 24, 1885.

The Alcoholic Derivatives of Pilocarpine.—M. Chastaing.—The author seeking to obtain the ethylated derivatives of pilocarpine, and especially dialcoholic compounds, has examined the behaviour of pilocarpine with ethyl iodide and bromide. The isoamylic derivatives are formed less easily than the ethylic derivatives.

On an Alkaloidal Substance obtained from the Culture-Broths of Koch's Microbion.—A. Gabriel Pouchet.—The author has analysed the pure cultivation broth of Koch's microbion and has established the presence of a liquid alkaloid the odour and poisonous properties

of which appear identical with those of the substances isolated from the dejections of cholera-patients.

Journal für Praktische Chemie.
New Series, Vol. xxxi., Parts 10 and 11.

Magnetic Circular Polarisation of Compounds with reference to their Chemical Constitution, and Remarks on the Preparation and Specific Gravity of the Bodies examined.—W. H. Perkin.—Some time ago the author published certain experiments and observations on the magnetic circular polarisation of chemical compounds. He emphasized the fact that a definite connection between the chemical composition of bodies and their magnetic power of circular polarisation had not yet been found. He also endeavoured to show that such connection could not be expected by means of the ordinary method of calculating the results, but that it might be obtained by comparing equal length units of the vapours, as an equal number of molecules are contained in such spaces. He showed that the same result might be reached by reducing the results of the examination of length-units of liquids to lengths which are proportional to their molecular weights. In this manner a definite relation appears between magnetic rotatory power and chemical composition. The author has carried out this work, and furnishes a description of the examination of 140 substances of the fatty series.

Apparatus for Chemical Elements.—Dr. J. Walter.—This paper requires the accompanying illustrations.

The Oxidation of Oleic Acid with Potassium Permanganate in an Alkaline Solution.—A. Saytzeff.—A claim of priority with reference to a communication by Max Gröger, in the *Berlin Berichte* (vol. xviii., p. 1268), on the oxidation of the fatty acids of tallow by means of potassium permanganate in an alkaline solution.

The Oxidation of Phenol by means of Nitrobenzol.—M. Siegfried.—The products of the reaction are oxalic and carbonic acids,—i. e., the same compounds as are generated on the oxidation of phenol by means of potassium permanganate. The nitrobenzol was reduced to azobenzol.

On Cyan-aniline and Certain of its Derivatives.—Adolf Senf.—By the action of nitrous acid upon cyaniline dissolved in glacial acetic acid or suspended in ether there is formed a crystalline compound, $C_{14}H_{15}N_5O_5$, which, if heated or boiled in water, splits off isocyanphenyl; in the latter case cyaniline is precipitated from the solution by soda-lye. Phenyl isocyanate reacts upon cyan-aniline with the formation of diphenyl-urea.

On Benzoin-anilide and its Derivatives.—K. Voigt.—The author has examined the action of aniline upon benzoin, and has thus obtained benzoin-anilide.

Cosmos les Mondes.
New Series, No. 23, July 6, 1885.

Glycogen in the Liver of an Executed Criminal.—The right lobe of the liver contained 1.85 per cent of glycogen, the left lobe 2, the spleen 0.25, and the kidneys distinct traces.

A deposit of calcium phosphate has been discovered in a cavern in Alahua county, Florida. The rock contains 57 per cent of pure tricalcic phosphate.

Nos. 24—26, July 13, 20, and 27.
These numbers contain no chemical matter.

No. 27, Aug. 3, 1885.

A Mr. Brown, of Fort Worth, in Texas, is said to have invented a telegraph and a telephone which require no battery or other source of electricity.

Cases of lead-poisoning in Paris have been traced to bread and flour. The miller concerned had filled up certain holes in his mill-stones with lead. He was one of the first victims.

MISCELLANEOUS.

British Association for the Advancement of Science.—The following are the names of the Officers and Committee of Section B (Chemical Science) of the Aberdeen Meeting of the British Association:—

President.—Prof. H. E. Armstrong, Ph.D., F.R.S., Sec. C.S.

Vice-Presidents.—Prof. A. Crum Brown, M.D., D.Sc., F.R.S. L. and E.; Prof. H. McLeod, F.R.S.; Prof. Brazier; Prof. Noel Hartley, F.R.S.; Prof. W. A. Tilden, D.Sc., F.R.S.

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The Papers brought before the Section were as follows:—

Report of the Committee on the Ultra-Violet Spark Spectra.

Prof. W. Ramsay.—The Non-Existence of Gaseous Nitrogen Trioxide.

Prof. W. Ramsay.—Observations on the Action of a Grove's Gas Battery.

Sir Henry E. Roscoe.—Remarkable case of the Polymerisation of Volatile Hydrocarbons at the ordinary temperature.

J. T. Brierley.—Some new Vanadium Compounds.

T. Jamieson.—The Essential Elements of Plants.

Prof. Odling.—A Plea for the Empiric Naming of Organic Compounds.

Prof. Carnelley.—The Periodic Law, as illustrated by certain properties of Organic Compounds.

Prof. Carnelley.—Suggestions as to the Cause of the Periodic Law, and the Nature of the Chemical Elements.

Dr. Gladstone.—The Value of the Refraction Goniometer in Chemical Work.

G. Gladstone.—The Refraction of Fluorine.

Dr. Gilbert.—Note on the Conditions of the Development and of the Activity of Chlorophyll.

Prof. Purdie.—The Action of Sodium Alcoholates on Maleic and Fumaric Ethers.

Dr. Orme Masson.—Sulphine Salts derived from Ethylene Sulphide.

Dr. Divers and T. Nakamura.—An apparently new Hydrocarbon from Distilled Japanese Petroleum.

J. Spiller.—Description and Exhibition of some new crystallised combinations of Copper, Zinc, and Iron Sulphates.

W. Ivison Macadam.—Description of a Mineral from Loch Bhruithaich, Inverness-shire.

W. Barlow.—A theory of the connection between the crystal form and the atom composition of Chemical Compounds.

Dr. A. J. Scott.—The Composition of Water by Volume.

F. Maxwell Lyte.—On the use of Sodium or other Soluble Aluminates for softening and purifying hard and impure water, and deodorising and precipitating sewage, waste water from factories, &c.

Prof. O. Lodge.—On Electrolysis.

Prof. A. Schuster.—On Helmholtz's Views on Electrolysis and on the Electrolysis of Gases.

Dr. C. R. Alder Wright.—On the Determination of Chemical Affinity in terms of Electromotive Force.

Shelford Bidwell.—On the Sensitiveness to Light of Selenium and Sulphur Cells.

Shelford Bidwell.—On the Generation of a Voltaic Current by a Sulphur Cell with a Solid Electrolyte.

Prof. Dewar.—On Solutions of Ozone and the Chemical Actions of Liquid Oxygen.

W. Barlow.—A Theory of the connection between the crystal form and the atom composition of Chemical Compounds.

Report on Vapour Pressures of Salt Solutions.

Report on certain Physical Constants of Solutions.

Prof. Dewar.—On Solutions of Ozone and the Chemical Actions of Liquid Oxygen.

Prof. Reinold.—The Size of Molecules.

Prof. Johnstone Stoney.—An approximate determination of the absolute amounts of the weights of the chemical atoms.

Prof. Johnstone Stoney.—On Macromolecules (Molecules of Matter in the crystalline state as distinct from the chemical molecule) and determinations of some of them.

Prof. Osborne Reynolds.—On Dilatancy.

Prof. Guthrie.—On Physical Molecular Equivalents.

Spencer V. Pickering.—Evidence deducible from the study of Salts.

Prof. Tilden.—On Dissolved Salts.

Dr. Russell.—The constitution of dissolved Cobaltous Chloride.

Prof. F. Clowes.—Barium Sulphate as a cementing material for Sandstone.

A. H. Allen.—An apparatus for determining the viscosity of oils.

J. Williams.—Action of Nitrous Gas on Amyl Alcohol.

Alex. Watt.—Exhibition of an Electrical Centrifugal Machine for Laboratories.

A. H. Allen.—On the Action of Water on Lead.

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By order,

J. H. CAMPION COLES, Secretary.

Eastbourne, 8th September, 1885.

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THE CHEMICAL NEWS.

VOL. LII. No. 1349.

ON THE ACTION OF SODIUM ALCOHOLATES ON FUMARIC AND MALEIC ETHERS.*

By Professor PURDIE, Ph.D., B.Sc., Assoc. R.S.M.

In a previous research (*Chem. Soc. Journ.*, 1881) the author has shown that by the action of sodium alcoholates in alcoholic solution on the ethereal salts of fumaric acid, products are obtained which by saponification yield alkyloxysuccinic acids; thus ethoxy succinic and butoxy succinic acids were prepared by the action respectively of a solution of sodium ethylate on ethylic fumarate, and of sodium butylate on butylic fumarate. The object of the present investigation is to elucidate the nature of the chemical reactions concerned in the change, and to compare the etheric acids obtained from fumaric acid with the corresponding additive products procured by similar methods from maleic acid.

Action of Sodium Methylate on Ethylic Fumarate.—When a solution of sodium methylate in methylic alcohol is added to ethylic fumarate, the first product of the action is methylic fumarate, which, however, is quickly converted into methylic methoxysuccinate, an oil boiling about 220° C., not without some decomposition. The sodium methylate used converts much more than its molecular proportion of fumaric ether into the addition compound, and it appears that an intermediate compound, a methylic methoxysodisuccinate, is formed, which, however, is continuously decomposed in the presence of alcohol, exchanging its sodium for the hydrogen of the latter while sodium methylate is reproduced. Methoxysuccinic acid procured by decomposition of its calcium salt with sulphuric acid is a crystalline solid melting at 101° to 103° C. Descriptions and analyses of the acid potassium salt and of the calcium and zinc salts are given. The observed conversion of ethylic fumarate into methylic fumarate by the action of sodium methylate is by no means an isolated instance of the interchange of alcoholic radicles between an ethereal salt and an alcohol, but in the instances hitherto observed the interchange is accompanied by partial saponification, as when ethylic oxalate is converted by the action of potassium methylate into potassic methylic oxalate. The author finds that in this reaction normal methylic oxalate is also produced, and that in a similar manner ethylic cinnamate is converted into methylic cinnamate; also, that if the ethylic salt is dissolved in methylic alcohol, the addition of certain salts, such as potassic carbonate, calcic chloride, and ignited borax, induces the interchange of alcoholic radicles.

The general subject of the interchange of alcoholic radicles between ethereal salts and alcohols, induced by various reagents, is being now investigated.

Action of Sodium Ethylate on Ethylic Fumarate.—This action has been previously described by the author, and ethoxysuccinic acid and several of its salts characterised. Further observations indicate that here also an intermediate sodium compound is formed, which, however, undergoes partial saponification, forming sodic ethylic ethoxysodisuccinate.

Action of Sodium Methylate and of Sodium Ethylate on Ethylic Maleate.—From the latter reaction no pure products could be obtained, but from the former a methoxysuccinic acid was procured, in its properties closely approximating to, if not identical with, the acid obtained from ethylic fumarate.

Action of Sodium Methylate on Hydric Methylic Maleate.—As it was found that a solution of maleic anhydride in methylic alcohol could be substituted for the normal maleic ether, this solution was used to obtain the material required for the further examination of the addition products from maleic acid. Hydric methylic maleate is formed by heating maleic anhydride with methylic alcohol, and the sodic methylic maleate, formed on the addition of sodium methylate, being soluble in the alcohol, is quickly converted into sodic methylic ethoxysodisuccinate, which by saponification yields the sodium salt of a methoxysuccinic acid. The acid, obtained as before from the calcium salt, crystallises in the same manner and has the same melting-point as the corresponding acid obtained from fumaric acid. The salts also which have been already mentioned are identical, with the exception of the zinc salts, which seem to differ slightly. Both salts crystallise with four molecular proportions of water, three of which are given off at 100°, while the remaining molecule is retained to nearly the temperature at which the substance undergoes decomposition; they appear, however, to differ in mode of crystallisation, and the salt derived from fumaric acid loses its last molecule of water of crystallisation at about 205° C., while that obtained from maleic acid does not become anhydrous till about 215° C. The high temperature required for the complete elimination of the water of crystallisation is remarkable, and an exact determination is attended with considerable difficulty, owing to the incipient decomposition of the salts at slightly higher temperatures.

Action of Sodium Ethylate on Hydric Ethylic Maleate.—By the addition of sodium ethylate to a solution of maleic anhydride in ethylic alcohol, and subsequent saponification of the product of the reaction, an ethoxysuccinic acid was obtained, the properties of which were found to be identical with those of the corresponding acid from fumaric ether. The calcium and barium salts were analysed and found to agree, as regards water of crystallisation and solubility, with the corresponding ethoxysuccinates previously obtained from fumaric ether.

The above experiments show that fumaric and maleic acids yield alkyloxysuccinic acids, which are identical with one another, or, if not identical, so closely resembling each other that their isomerism must be of the same nature as that of substances which differ only in optical and crystallographic characters. This supposition is by no means improbable in view of the fact that the malic acid prepared from fumaric acid by the action of caustic soda seems to differ from ordinary malic acid and from Kekulé's inactive malic acid, and in view also of the discovery of Kekulé and Anschütz that fumaric acid on oxidation gives racemic acid, while maleic acid yields meso-tartaric acid. On the other hand, the slight differences found to exist between the zinc methoxysuccinates—the only difference observed so far between the corresponding addition products—may be due to slight impurity in one or both of the salts, a supposition not improbable, considering that the acids did not give absolutely definite melting-points.

K. Grosner has recently shown ("Inaugural Dissertation," Würzburg, 1885), that the ethers of the isomeric pyrocitric acids, when treated with sodium alcoholates, yield alkyloxypyrotartaric acids; he finds, however, that itaconic and mesaconic ethers yield the same acid, and citraconic ether an acid which, though isomeric, is essentially different in its properties from the other. In view of the relation of citraconic to mesaconic acid being in so many respects similar to that subsisting between maleic and fumaric acids, these results are difficult of explanation.

The author intends, as soon as he has a sufficient quantity of material at his disposal, to investigate the optical and crystallographic characters of some of the salts of the ethoxy- or methoxysuccinic acid, obtained from the two parent acids, with the object of determining the identity or isomerism of the acids in question. He purposes also preparing alkyloxysuccinic acids direct from malic acid,

* Abstract of a Paper read before the British Association, Section B, Aberdeen Meeting.

so as to compare these acids, obtained from various sources, with each other, and also with the isomeric malic acids now being investigated by Anschütz. He also reserves for further study the intermediate sodium compounds to which reference has been made.

NOTE ON THE CHEMICAL COMPOSITION OF THE MILK OF THE PORPOISE.

By Professor PURDIE, Ph.D., B.Sc., Assoc. R.S.M.

PROFESSOR McINTOSH having kindly placed at my disposal a small specimen of milk which he extracted from the mamma of a porpoise recently caught in the Bay of St. Andrew's, I made an analysis of it. The subject is one of somewhat remote practical interest: it is not likely that the milk of the porpoise will become an article of ordinary consumption, but its composition is curious, and some of your readers may be interested in the analytical results. The quantity of material at my disposal being very small, the numbers cannot lay claim to great accuracy, and it must be noted that the presence of milk-sugar is more than doubtful. The milk solids, deprived of fat by extraction with ether, were treated with dilute alcohol after the usual manner; but the substance thus separated from the albumenoids was too small in quantity for further examination, and although set down as milk-sugar, it was very probably some albumenoid matter.

Water	41.11
Fat	45.80
Albumenoids	11.19
Milk-sugar (?)	1.33
Mineral salts	0.57

100.00

The most remarkable point about the composition of the milk is the large percentage of fat it contains, a constituent of food which, I presume, the cetacean, from its mode of life, would require in larger proportion than ordinary mammals do. The milk was not of an inviting appearance, being of a yellow colour and thick consistency, and possessing a "fishy" smell. The specific gravity of the milk, in spite of its solid contents, differed little from that of water.

Chemical Laboratory,
University, St. Andrews,
September 17, 1885.

New South Wales Asbestos.—An asbestos mine exists on the spur of a hill about two miles from Gundagai, New South Wales, in which the lode has been driven upon for a distance of 90 feet and a shaft 100 feet has been also sunk. The mineral occurs in a serpentine formation similar to quartz veins, and is mined in the same manner. The material is very abundant, and is of as good quality as any in the world. The shareholders have started an asbestos manufactory, in which they propose to work up asbestos for various purposes. Among other useful purposes to which the asbestos is put is the making of a fire-proof paint. On the same property another class of asbestos has been discovered, and worked in connection with gold. The lode is peculiar in character, and with one or two minor exceptions is almost identical with the famous Lucknow lode, which has proved so rich in gold. In some instances veins of calc-spar make their appearance in the lode, bringing gold with them every time. Arsenical and iron pyrites are abundant, and so far as the lode has been worked it has proved payable by crushing tests, without one failure.

ESTIMATION OF LIGHT HYDROCARBONS AND NON-NITRIFIABLE SUBSTANCES IN COMMERCIAL BENZOLS.

By BENJAMIN NICKELS, F.C.S., F.I.C.

SOME five years back I pointed out through the medium of your journal (CHEMICAL NEWS, vol. xliii., pp. 148 and 250) the remarkable influence of carbon bisulphide in masking the true character of benzol, and the inference to be drawn from observation of percentages obtained by the ordinary distillation test. After a prolonged period of slumber the question of "benzol testing" would appear to have revived, and one method at least has been submitted from the Continent that aims at nothing short of estimating the actual benzol and toluol contained in the commercial products offered for sale.

At the date of the contribution referred to this achievement was impracticable upon the small samples submitted for examination; but the more recent introduction of the Le Bel Henninger Tube has, within very close limits, rendered this operation possible, and offers facilities for the accomplishment of results probably unattainable by any other method of laboratory fractioning. So far, however, as the commercial testing of benzol is concerned, and so long as 90 per cent and 50.90 per cent is manufactured and sold, the introduction of very exact and elaborate methods of analyses are scarcely needed. The products referred to are tolerably uniform in composition as regards benzol and toluol, and the only operation necessary that of determining those substances usually termed "Non-nitrifiable," or "Light Hydrocarbons," but more correctly speaking non-colour yielding products, always present in variable proportion.

I venture to think that a very slight extension of the test in daily use will admit of this estimate, sufficiently near at least for the present requirements of commerce; but where closer demonstration is needed recourse must be had to the use of the Henninger tube, which furnishes sufficient material for actual examination.

In carrying out these tests two methods may be followed, both of which were detailed at some length in the numbers of the CHEMICAL NEWS herein referred to. The interval that has elapsed has left nothing to add to them, and the method of procedure is substantially the same. Take any convenient quantity of the benzol to be examined, say 300 c.c., and add to it 30 or 40 c.c. of a saturated solution of potassium hydrate in absolute alcohol, methylated or otherwise; subject this mixture to frequent agitation during the space of half an hour. Generally speaking, if of 90 per cent quality and of London make, the fluid becomes pasty or semi-solid, from formation of potassium xanthate. This is to be filtered off, carefully folding the paper, when drained, and gently pressing it with a spatula against the sides of the funnel, so as to press out residual benzol. To the benzol so treated add cold water in a capacious separating funnel, and agitate briskly for a few minutes; allow time for separation of the contents into two layers, and run off the lower stratum of water and alcohol washed out of the benzol; repeat the washing with water; finally, remove the benzol into a stoppered bottle, and agitate with a small quantity of "Plaster of Paris" (gypsum); this effects immediate removal of water held in suspension. Repeat the operation a second time, using only half the quantity of alcoholic potash, say 15 c.c. Having completed this purification and removed the carbon bisulphide previously contained, proceed to test the benzol by the usual retort method, noting temperature at which the "drop" falls, and distillate at the 84° point. The difference observed will be considerable. First, entire disappearance of alliaceous odours; secondly, decrease of specific gravity from 0.885 to 0.882, or 0.880, according to the quantity of carbon bisulphide originally present, and removed by the alcoholic potash treatment; thirdly, dis-

appearance of abnormal boiling-points, rising from 79° or 80° to 83° for drop, and falling from 25 or 30 per cent to 6 or 8 per cent of the 84° point. A comparison of this product with a standard 90 per cent benzol prepared by admixture of pure material affords a tolerable idea of its character and of the quantity of "light hydrocarbons" (paraffins) present, sufficiently so, I think, for all practical purposes.

The standard 90 per cent used in these comparisons is prepared by admixture of pure benzol, sp. gr. 0·885, 70 pts.; pure toluol, sp. gr., 0·771, 30 pts., and which represents the proportion of benzol present in a good 90 per cent. The specific gravity of this mixture is 0·8805. The boiling-points as obtained by the ordinary 8-oz. retort method of testing, as follows:—

At 85·4° C.	drop
86·2	5 per cent
86·6	10 "
87·2	20 "
87·8	30 "
88·8	40 "
89·8	50 "
91·4	60 "
93·2	70 "
96·2	80 "
102·0	90 "

And from which it will be seen, without much further examination, that the wider the departure of drop in distillation from 85·4° the greater will be the quantity of "light hydrocarbons" present, a deduction further confirmed by specific gravities on the light side of 0·8805.

The manner in which the percentage of these substances may be obtained will be referred to later on. Carbon bisulphide may be estimated direct in a solution of the potassium xanthate removed on filtering by standard solution of copper sulphate, or by computation from decrease in specific gravity.

1 per cent by vol. of carbon bisulphide raises the	
density by	0·0033
2 per cent ditto, ditto,	0·0065
3 per cent ditto, ditto,	0·0093

In preparing mixtures to illustrate the statement advanced, it became necessary to procure a sufficient quantity of the lighter hydrocarbons present in most commercial benzols, and for that purpose a quantity of the material known as "light stuff," distilled from "90 per cent" in the process of factory rectification was taken; the original specific gravity of this fluid was 0·899, and successive treatment with alcoholic potash reduced it to 0·884, showing a large proportion of carbon bisulphide in admixture. Fractioning the portion so treated through a six-bulb Henninger tube afforded fluids varying considerably in specific gravity, the lightest fraction showing 0·857 was again fractionated and yielded products as follows, on 80 c.c. taken:—

First.	10 c.c.	0·760
Second.	10 "	0·825
Third.	10 "	0·858
Fourth.	10 "	0·878
Fifth.	10 "	0·880
	30 "	residue 0·883

For reasons that will also be explained later on, the fraction distilling at the lowest temperature and showing the lowest specific gravity, *i.e.*, 0·760, was selected as representing typical "light hydrocarbons," and the following mixture prepared for the purpose gave results agreeing very closely with those observed in many commercial 90 per cent benzols. The illustration will exhibit the quantity of these substances that may be present in commercial products:—

Pure benzol	63 parts
Pure toluol	27 "
Light hydrocarbons, sp. gr. 0·760	8 "
Bisulphide of carbon	2 "

100

The sp. gr. of this fluid was 0·879.

Tested in the ordinary method by distillation in an 8-oz retort it furnished—

At 79·0° C.	drop
84·0	21 per cent
85·5	30 "
87·2	40 "
88·5	50 "
90·4	60 "
92·6	70 "
95·6	80 "
100·0	90 "

After treatment with alcoholic potash the sp. gr. fell to 0·871, indicating bisulphide of carbon (removed) and of hydrocarbons (present) lighter than the mixture of benzol and toluol originally taken.

Tested in the usual manner it gave—

At 82·5° C.	drop
84·0	5 per cent
85·0	10 "
86·2	20 "
87·2	30 "
88·2	40 "
89·6	50 "
91·2	60 "
93·3	70 "
96·7	80 "
100·0	88 "

Answering to an excellent specimen of commercial 90 per cent, notwithstanding it contained 8 per cent of "light hydrocarbons" or "non-nitrifiable compounds."

It will be readily seen from these tables that there is little difficulty in arriving at tolerably correct conclusions respecting the substances sought without the aid of elaborate analysis, and a succeeding chapter will show the manner in which they may be estimated.

The New South Wales Tin-Fields.—These differ in some respects from those of Perak; for instance, the ore in the latter country is usually found in the granite formations overlaid with lime and sandstone, whereas in Australia no tin has been discovered under similar conditions. At first it was thought that the tin ore in the New England District was confined to existing shallow streams, and that it was useless to look for it at any considerable distance below the surface. It has since been discovered at various depths, from a few inches to 250 feet. The first deep stream tin found at Vegetable Creek was in 1873. The lead was traced along a distance of four or five hundred yards. At a depth of 50 feet very heavy deposits were found under basaltic rocks. Several other leads were afterwards struck at a greater depth, running almost parallel with the first. It is now believed that tin ore exists throughout all the old river beds and valleys of the district. Some of the deposits are covered with immense masses of basaltic rocks, which will require a heavy expenditure of capital to remove, but the ore is so rich and abundant that the outlay can very well be afforded. There is reason to believe, however, that many years will elapse before the surface mines are exhausted. During the year 1883 the Vegetable Creek Tin-Mining Company obtained 2000 tons of ore from an area of 5 acres. The Secretary for Mines states in his last report that the flow of basalt and other geological formations in New England District indicate that stream tin will last for many years.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from page 165.)

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
|| Following a date signifies publication discontinued.

140. PHILOSOPHICAL (THE) MAGAZINE. Comprehending the various branches of science, the liberal and fine arts, agriculture, manufactures, and commerce. By Alexander Tilloch. 42 vols., 8vo. London, 1798-1813.

United in 1814 with the *Journal of Natural Philosophy*, by William Nicholson, and continued under the title:

- [a] Philosophical (The) Magazine and Journal. Comprehending the various branches of science, the liberal and the fine arts, geology, agriculture, manufactures, and commerce. By Alexander Tilloch, [from 1824 by Alexander Tilloch and Richard Taylor]. 26 vols. (XLIII.-LXVIII.), 8vo. London, 1814-'26.

United in 1827 with the *Annals of Philosophy*, or *Magazine of Chemistry*, by Richard Phillips, and continued under the title:

- [b] Philosophical (The) Magazine; or, *Annals of Chemistry, Mathematics, Astronomy, Natural History, and General Science*. New and united series of the *Philosophical Magazine and Annals of Philosophy*. By Richard Taylor and Richard Phillips. 11 vols. (I.-XI.). 8vo. London, 1827-'32.

United in 1832 with the *Edinburgh Journal of Science*, by David Brewster, and continued under the title:

- [c] London and Edinburgh Philosophical Magazine and Journal of Science. Conducted by David Brewster, Richard Taylor, and Richard Phillips. New and united series of the *Philosophical Magazine and Journal of Science*. 37 vols., (I.-XXXVII.), 8vo. London, 1832-'50.

Continued under the title:

- [d] London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science. Conducted by David Brewster, Richard Taylor, Richard Phillips, Robert Kane, and William Francis. Fourth Series. 50 vols., (I.-L.), 8vo. London, 1851-'75.

Fifth series. Edited by R. Kane, W. Thomson, and W. Francis. 18 vols. (I.-XVIII.), 8vo. London, 1876-'84+

141. PIRIA (IL). *Giornale di scienze chimiche*. Napoli, 1875.

POGGENDORFF'S ANNALEN.
See *Journal der Physik*.

POLLI, GIOVANNI.
See *Giornale di farmacia, chimica e scienze accessorie*.

POPULAR SCIENCE NEWS.
See *Boston Journal of Chemistry*.

POST, JULIUS.
See *Zeitschrift für das chemische Grossgewerbe*.

142. PROCEEDINGS OF THE AMERICAN CHEMICAL SOCIETY. 1876-'78. 1 vol., 8vo. New York, 1877.

Continued under the title:

- [a] *Journal of the American Chemical Society*. 6 vols., 8vo. New York, 1879-'84+

143. PROCEEDINGS OF THE CHEMICAL SOCIETY OF LONDON. 1841-'43. 1 vol., 8vo. London, 1843.

- [a] *Memoirs and Proceedings of the Chemical Society of London*. 1841-'48. 3 vols., 8vo. London, 1843-'48.

- [b] *Quarterly Journal of the Chemical Society of London*. 14 vols. (I.-XIV.), 8vo. London, 1849-'62.

Continued under the title:

Journal of the Chemical Society of London. 1 vol. (XV.), 8vo. London, 1862.

Second Series. 14 vols. (I.-XIV.) London, 1863-'76.

Third series. 2 vols. (I.-II.). London, 1876.

Fourth series. 16 vols. (I.-XVI.). London 1877-'84.

PUBLIC ANALYSTS, SOCIETY OF.
See *Analyst (The)*.

QUESNEVILLE, Dr.
See *Revue scientifique et industrielle*.

144. RACCOLTA FISICO-CHIMICA ITALIANA. Ossia collezione di memorie originali edite ed inedite di fisica, chimici e naturalisti italiani dell' Ab. Francesco Zantedeschi. 3 vols., roy. 8vo. Venezia, 1846-'48.

Followed by:

Annali di fisica, dell' Abbate F. C. Zantedeschi. 1 vol., roy. 8vo. Padova, 1849, '50.

- 144 A. RAGGUAGLI. *Laboratorio chimico-agrario di Perugia*. Dir.: Giuseppe Bellucci. 8vo. Perugia, 1883.

(To be continued).

ANALYSIS OF
THE LEAVES OF ILEX CASSINE.*

By F. P. VENABLE, Ph.D.

THE Yopon (*Ilex Cassine*, Linn.), is described in Hale's "Woods and Timbers of North Carolina" as an elegant shrub, 10 to 15 feet high, but sometimes rising into a small tree, 20 to 25 feet. It has, according to the same authority, for its *habitat* the strip of country from Virginia southward along the coast, never extending, however, very far into the interior. The leaves are $\frac{1}{2}$ to 1 inch long, with a smooth surface and fine serrated edge. The plant is an evergreen, and its dark green leaves and bright red berries make it attractive as an ornamental shrub. In the region of the Dismal Swamp, and in other sections, the leaves are annually gathered, dried, and used for tea. This decoction is, according to Hale, oppressively sudorific, at least to those unaccustomed to its use. The famous "Black Drink" of the Southern Indians was made from the leaves of this shrub. "At a certain time of the year they come down in droves from a distance of some hundred miles, to the coast for the leaves of this tree. They make a fire on the ground, and putting a great kettle of water on it, they throw in a large quantity of these leaves, and seating themselves around the fire, from a bowl that holds about a pint, they begin drinking large draughts, which in a short time occasions them to vomit freely and easily. Thus they continue for the space of two or three days, until they have sufficiently cleansed themselves, and then, everyone taking a bundle of the leaves, they all retire to their habitations." Having on hand a small sample of these leaves, procured from New Berne during the winter of 1883, it seemed desirable to make an examination of them to decide, if possible, the presence of any alkaloid or other principle which would make the decoction useful as a beverage. The usual treatment with magnesium oxide, exhaustion with water, separation by

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

* From the *Journal of the American Chemical Society*, vol. vii, No. 4.

means of chloroform, and subsequent purification, was adhered to, resulting in obtaining a small amount of a white substance slightly soluble in water, more so in alcohol, and easily soluble in chloroform, which gave distinctly the tests for caffeine, especially the murexide reaction, and very closely resembled a specimen of pure caffeine from Powers and Weightman.

This caffeine formed 32 per cent of the dried leaves. Later on, in May, a much larger supply of the same leaves was obtained from the neighbourhood of Wilmington. A more thorough examination of them was then made with the following results:—

Water in air-dried sample..	..	..	13.19
Extracted by water ..	..	..	26.55
Tannin ..	..	..	7.39
Caffeine..	..	..	0.27
Nitrogen (on combustion) ..	..	..	0.73
Ash ..	..	..	5.75

The analysis of the ash is shown in Column I.

	I.	II.
CaO ..	10.99	12.34
MgO ..	16.59	11.39
Na ₂ O ..	0.47	7.28
K ₂ O ..	27.02	2.98
MnO ₂ ..	1.73	2.50
Fe ₂ O ₃ ..	0.26	3.41
SO ₃ ..	2.50	0.92
Cl ..	0.66	0.71
P ₂ O ₅ ..	3.34	5.54
SiO ₂ ..	1.32	44.75

The Maté or Brazilian holly (*Ilex Paraguayensis*) belongs to the same genus. Its ash analysis, as made by Senor Arate, is given in Column II. The plant grows wild in Brazil, and is very largely used by the South Americans. It has, according to Peckolt (*Pharm. Journ. Trans.* [3], 14, 121—124; Abstract, *Journ. Chem. Soc.*, 1884, 479) been planted, and seems to succeed well, in the Cape of Good Hope, Spain, and Portugal. It is stated that six different species of *Ilex* are used in the preparation of this tea. Peckolt gives, in his analysis of the air-dried leaves, the percentage of caffeine as 0.639. The average percentage of analyses, by different authors, is about 1.3. I can find mention of only one other *Ilex* used as a substitute for tea. The analysis of this by Ryland and Brown is quoted in Blythe's "Composition and Analysis of Foods," p. 343. It is called the *Ilex Cassiva*, is said to be used as a tea in Virginia, and the percentage of caffeine is given as 0.12. This is probably the same thing as the Yopon, the analysis of which is given above, and the "cassiva" may be a misprint for "cassine."

University of North Carolina.

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Prof. CHAS. E. MUNROE, U.S.N.A.

(Continued from p. 166.)

THE Pennsylvania Railroad Company has issued the following rules concerning the transportation of explosives over its system of lines:—

High explosives such as Atlas, Hercules, Giant, Dittmar, Commercial, Ætna, Hecla, and other nitro-glycerin powders, will be received for shipment only under the following conditions:—

First. Shipments to be packed in strong boxes, not too large to be readily handled by one person, and each

package to be plainly marked "Explosives"—"Dangerous" on top, and on one side or on one end.

Second. It is understood that in these articles the nitro-glycerin is thoroughly absorbed in charcoal, sawdust, infusorial earth, wood fibre, carbonate of magnesia, or other similar substances, and that the amount of nitro-glycerin is such that the temperature of the hottest summer day will not occasion a leakage. Should any package show outward signs of any oily stain, or other indication that absorption is not perfect, or that the amount of nitro-glycerin is greater than the absorbent can carry, the packages must be refused in every instance, and must not be allowed to remain on the property of the company.

Third. Nitrate or other explosive preparations not in accordance with above specifications (except ordinary black powder) will in no case be received for shipment.

Fourth. Shipments must be loaded so as to lie bottom side down, it being understood that the cartridges are so placed in the boxes that they will lie on their sides, and never on their ends when so loaded. The boxes must be so placed in car that they cannot fall to the floor under any circumstances.

Fifth. Shipments of common black powder may be received if packed in good substantial iron or wood kegs. Packages not to exceed one hundred and fifty pounds in weight, unless for export, when larger packages will be received.

Sixth. In no case will percussion caps, exploders, safety squibs, fulminators, friction matches, or any other articles of like nature be loaded in same car with any of the above explosives. There cannot be too great care exercised in this matter.

Seventh. Safety fuse will be received for shipment at any time it is offered, and the restrictions in regard to shipping powder do not apply to it.

Eighth. As the special powder cars will be taken out of this service, agents must know that none of the above explosive substances are loaded at their stations in old cars having loose boards or cracks in the roof or sides. Cars for carrying these explosives must be first-class in every respect, must be tight everywhere, and must have doors that can be closely shut, leaving no cracks for sparks to get in. When in full carloads the doors must be stripped.

Ninth. Every car containing any of the above explosive substances, either full carload or small package, must be plainly marked on both sides, "Powder—Handle Carefully," so that those having charge of it will not do anything ignorantly to incur danger. This should be done by the shipper of full carloads and by the agent when the packages are loaded in car at his station.

Tenth. Conductors must not take from any station or siding any car known to contain an explosive substance, unless Rules 8 and 9 have been complied with, and such cars must be placed in their train as near the middle as possible.

The law provides heavy penalties, both to shippers and common carriers, for violation of these rules, and agents should be careful to see that such shipments are put up, marked, and forwarded only under their proper names, and in accordance with these provisions.

The *Iron Era*, of Dover, New Jersey, December 22, 1883, contains an account of the opening of the works of the American Forcite Powder Manufacturing Company at Lake Hopatcong on the Morris Canal. The works number upwards of forty buildings, covering an area of 450 acres of land, heavily wooded. The buildings, where the powder manufacturing is to be done, are situated from 100 to 200 feet apart, and placed in excavations in the side-hills, so that only one side is exposed. All these buildings are lined, ceiled, heated by steam, and furnished with water. The nitro-glycerin is carried from the converting house to the mixing house by gravity, through large india-rubber pipes, well protected and laid under the ground. The converting house is a three-storey frame building 32 × 32 feet. The converter is in the third storey,

* From the *Proceedings of the U.S. Naval Institute*.

As it is proposed to continue these notes from time to time, authors, publishers, and manufacturers will do the writer a favour by sending him copies of their papers, publications, trade circulars, or expert testimony in infringement cases

the separating tanks and washing tanks are on the lower floors. The spent acid flows through leaden pipes to the acid house, where it is regenerated and forced back to the converting house 900 feet away. The acid house is of brick, 25 × 65 feet, and contains four large retorts and condensing towers for regenerating the spent acids. The magazines are built in excavations in the hill so that the roofs are below the surface of the ground. The structures are of brick with roofs of corrugated iron. This roof forms a lightning conductor, and has rods leading from the four corners into the ground, as in the Belgian Government magazines. A system of ventilation, through hollow bricks, allows the air to enter at the bottom and escape at the top. A reservoir capable of furnishing 60,000 galls. of water daily, and an ice-house, 30 × 50 feet, are connected with the works. The concern has a capacity of five tons of powder per day, and beginning with a force of 50 men, it is expected to soon increase to 100.

Forcite is described as a hard plastic substance, looking very much like india-rubber and as tough. The principal advantages claimed for it are greater safety in handling than other nitro-glycerin compounds possess, and imperviousness to water. It may be exposed to a temperature of 120° without allowing the nitro-glycerin to exude, and may be submerged under water a long time without damage. There are now three factories in Europe making this powder.

U.S. Letters Patent No. 242,783, dated June 14, 1881, and granted to John M. Lewin, of Paris, France, describe "Forcite" and the method of preparing it as follows:—

Hitherto nitro-glycerin has been reduced to a gelatinous mass by dissolving gun-cotton or nitro-cellulose therein, and nitre has been incorporated in such mass. In the present invention neither gun-cotton nor other form of nitro-cellulose is required, but the cellulose is used in an unnitrated condition.

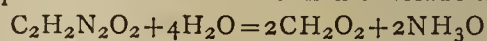
In order to carry the invention into effect, cotton or other form of cellulose is treated alternately with alkalis and acids, as in the cleaning of paper-stock, or in any ordinary or suitable way, in order to remove foreign materials and leave pure cellulose. This is then reduced to powder by a picker or grinding-cylinder, and is subjected in a close vessel to the action of high-pressure steam until the reaction takes place by which the cellulose is converted into a gelatinous mass. At this moment the operation is stopped, the gelatinous mass obtained (which can be preserved indefinitely under water) is allowed to cool, and is then dissolved in, or thoroughly and uniformly incorporated with, nitro-glycerin, the result being a sort of jelly. The solution or incorporation is effected by the aid of heat. A temperature of 40° C. is suitable, and can easily be obtained by a water-bath in which the water is heated to, say, 90° C. Nitre is incorporated with the nitro-glycerin and gelatinised cotton described to form the new explosive—forcite.

The proportions may vary. One of the best compositions is nitro-glycerin, seventy-five; gelatinised cotton, seven; and nitre, eighteen. Dextrin can be used instead of a large part of the gelatinised cellulose. In such cases the following composition is preferred:—Nitro-glycerin, seventy; gelatinised cellulose, one; dextrin, five; nitre, fifteen; ordinary cellulose, nine. The ordinary cellulose is, or may be, in the form of powder.

Forcite thus prepared is a plastic mass, having the power of nitro-glycerin, and being attended in its making, carrying, and keeping with less danger than explosive compounds before known, and even than "blasting" or "mining" powder, properly called. It has the remarkable and most advantageous property of exploding when confined or charged in a drill hole, as well as by the action of special primers or caps as by ordinary fuses, and of burning without explosion in the open air. Its manufacture is less costly than other compositions of nitro-glycerin. The nitro-glycerin is so perfectly united with the other materials that it is not separated by sulphuric ether or alcohol, and water has no action upon it. The nitro-glycerin

therefore preserves its properties without alteration, even under water.

The *Journ. Chem. Soc.*, January, 1884, contains four interesting articles on the fulminates. The first (p. 13), by E. Divers and M. Kawakita, entitled "On the Constitution of the Fulminates," discusses the work of Carstanjen and Ehrenberg* and of Steiner, and gives the results of their own investigation. They added dry fulminate of mercury† to fuming hydrochloric acid, without danger, and obtained the whole of the nitrogen as hydroxylamin chloride free from hydrocyanic acid. When dilute HCl was used much HCN was given off. By distillation with fuming HCl formic acid was obtained; careful search showed neither oxalic nor glyoxylic acid among the decomposition products. The authors then conclude that—



represents the change which mercury fulminate suffers under the influence of concentrated hydrochloric acid.

On page 19 (*Ibid.*) E. Divers treats of the "Theory of the Constitution of the Fulminates." The knowledge that the fulminates contain two isonitrosyl radicals or their equivalent, and two formic carbons, greatly simplifies the question as to the constitution of fulminic acid, and divests the answer of much of its difficulty.

A theory of the constitution of the fulminates must, before it can be accepted, include an explanation of the formation of these bodies; of their capacity to yield cyanogen compounds, and to yield all their nitrogen as hydroxylamin, and all their carbon as formic acid; of their general, if not entire, disability to give dicarbon decomposition products; of the difficulty in replacing more than half their silver or mercury by another metal; of their reactions with chlorine and bromine, and of their explosive character.

A notice‡ of four of the formulæ which have been proposed will make apparent the extent to which they each fulfil these requirements of a theory of the subject:—

Berzelius's modernised..	$\text{Ag}_2\text{O}(\text{AgN})_2\text{C}_4\text{N}_2\text{O}_3$
Kekulé's	$\text{NCCH}_2(\text{NO}_2)$
Armstrong's	HO.N:C:CH(NO)
Steiner's	HO.N:C:C:N.OH

The first furnishes an explanation of the explosive character of the fulminates, representing the metal as combined with both nitrogen and oxygen. It also shows a difference in the relations of the two atoms of hydrogen, or of the metal in place of them.

The second also explains, but in a less satisfactory way, the fulminating character of these salts. It shows why cyanogen derivatives are so readily formed from them, and represents half the nitrogen as oxidised and able to become hydrogenised and produce hydroxylamin just as nitroethane can. But it makes a nitroxyl radical to be introduced by nitrous acid, which, as Armstrong and Groves point out, it should not do. It entirely fails to account for the two kinds of acid properties the fulminates possess, and allows of only half the nitrogen becoming hydroxylamin.

The third formula explains the dual nature of the acidity, and also the formation of hydroxylamin and of cyanogen compounds. It is interesting as exhibiting the presence of isonitrosyl in fulminates before this had been established by experiment. But it has become open to the objection, through the recent conclusions of Victor Meyer and his school, that nitrosyl does not get introduced into a CH_3 or CH_2 group, and probably its proposer would now reject it himself on that account.

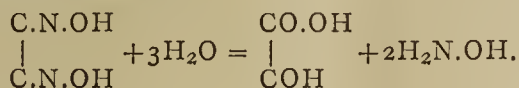
The fourth formula is satisfactory as regards hydroxylamin and formic acid, but it does not make the cause of

* *Proc. Nav. Inst.*, viii., 667.

† This operation seemed to involve no danger. The fulminate was free from metallic mercury. The presence of the latter is due to the action being too much checked, in accordance with caution usually recommended. The action should be allowed free course.

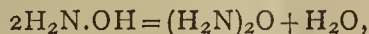
‡ *Proc. Nav. Inst.*, viii., 667.

the explosive character apparent, nor the production of cyanogen compounds very probable, and, above all, it represents the two hydrogens as being of equal value. Besides this, it makes the hydrogen of isonitrosyl strongly basic, although this is not its character in other isonitrosyl compounds. We should expect, too, the formation of glyoxylic acid. Thus—



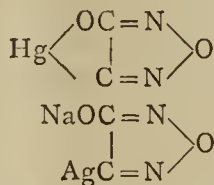
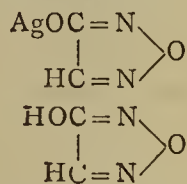
Divers, then, presents a theory of the constitution of the fulminates which he believes agrees with all the known facts. It is that they are formed from (1) an alcohol residue in which the hydrogen has been replaced by metal, and which retains only the carbon and oxygen; and (2) a condensed hydroxylamin residue.

Hydroxylamin is now always formulated as an amine, $\text{H}_2\text{N.OH}$, but between doing this and formulating it as an ammonium hydroxide, $\text{H}_3\text{N}(\text{OH})_2$, there is little to enable us to decide. Its want of odour is, perhaps, in favour of the latter view; but it may quite probably have still another composition. It may consist, like ether, of two molecules condensed into one with loss of a molecule of water, thus—

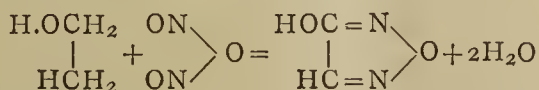


That is, there is no known reason why $(\text{H}_2\text{N})_2\text{O}$ should not be the composition of hydroxylamin, oxyammonia, or *amidogen oxide*, its derivatives being related sometimes to this condensed form, sometimes to its simple or alcoholic form of amidogen hydroxide. There is at least evidence of the existence of the condensed or oxide form in the action of hydrochloric acid on hydroxylamin.

For these reasons Divers gives the following formulæ for the fulminates:—



and proceeds to consider their sufficiency for expressing the facts. First, as to formation. The alcohol yields two-thirds of its hydrogen to the oxygen of the nitrogen trioxide, and its carbons unite with nitrogen,

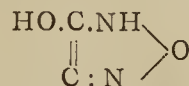


The fulminic acid here represented will either only be thus formed in the presence of mercury or silver nitrate, or it will be a transition body which would at once decompose but for the presence of the mercury or silver nitrate, with which it at once undergoes double decomposition, in virtue of being a cyanogen derivative, and just as the otherwise unstable hydrogen cyanide would do in similar circumstances. It is well known, on the authority of Liebig, that nitrogen trioxide, passed into an alcoholic solution of either mercury or silver nitrate, precipitates fulminate without evolution of gas.

Secondly, as to the character of the metallic or basic element of their constitution. The formation of fulminates under the operation of mercury or silver nitrate, and the displacement of only half these metals from their fulminates by the action of soluble chlorides, are facts in entire agreement with what we know of the cyanides of these metals. Hydrocyanic acid decomposes strongly acid solutions of mercury and silver, and potassium cyanide is decomposed even by the oxides of these metals, as every chemist knows, and their cyanides give stability to the unstable alkali cyanides when combined with them.

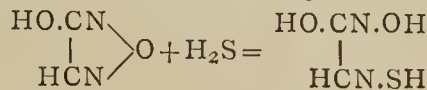
Thirdly, as to their explosive properties. To account for these, the presence together of the constitution of a cyanide and that of an oxygen salt seems fully sufficient.

Berzelius's view of the matter resembles this explanation, allowance being made for the state of chemistry at the time he wrote. Indeed a formula may be given making out, as his does, that the metal is half united to nitrogen and half to oxygen.

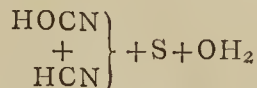


This formula is compatible with most of the facts; but that of the formation from alcohol is, as regards the transference required of the hydrogen from the carbon to the nitrogen, difficult to explain. Its relation to hydroxylamin is also not very simple.

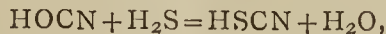
Fourthly, as to the production of cyanogen compounds in their decompositions. This follows from the nitrogen being directly united to the carbon. The union with hydrogen sulphide (Steiner) may take place in this way:—



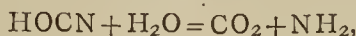
This becomes, in presence of water,—



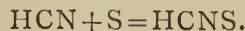
and then with a second molecule of hydrogen sulphide,—



besides—

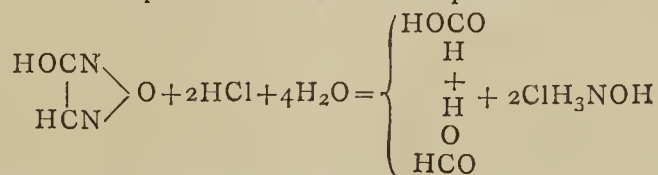


and—



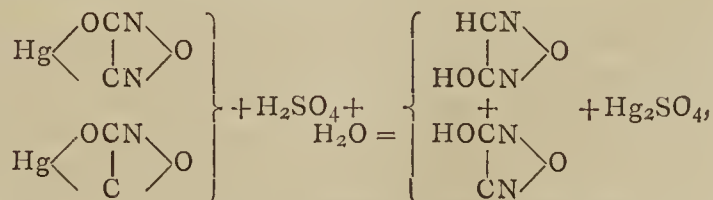
Gladstone's formation of urea by ammonia and hydrogen sulphide follows from the preceding representation, in which cyanic acid appears, as this would, of course, give urea with the ammonia also present.

Fifthly, as to the formation of hydroxylamin and formic acid. To explain this we have the equation—



the $\equiv \text{N}_2\text{O}$ taking one molecule of water to become $2(=\text{NOH})$, and the C_2 taking another to separate them (as when oxalic acid becomes formic and carbonic acids, and just for the same reason that they are only loosely held together, through all the ethane-hydrogen having been displaced). Each $=\text{CN}-$ takes a molecule of water to separate its elements to form on the one side carbonyl and on the other amidogen, as is usual with the cyanogen radical.

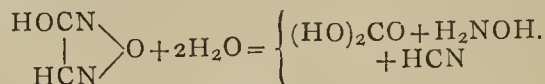
The production of formic acid and other monocarbon compounds only is thus seen to be consistent with the dicarbon constitution derived from alcohol, while the formation of oxalic acid is not very improbable, provided there is a source of oxygen, but Divers and Kawakita were unable to obtain it. The reaction for carbonic acid is as follows in its first stage:—



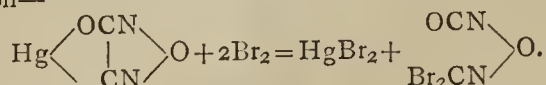
and then the fulminic acid shown in the upper line yields formic acid, and the lower (transition) acid yields formic acid and carbonic acid by further hydration.

Carbonic acid and hydrocyanic acid are also formed together under the influence of dilute hydrochloric acid. In this case only half the cyanogen of the fulminate

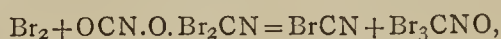
undergoes hydration—the half combined with hydroxyl, and apparently therefore less stable than the other:—



Lastly, as to the action of bromine or chlorine. The primary reaction of bromine to form a body corresponding in composition with fulminic acid, but certainly not in constitution, admits now for the first time of ready explanation, without resorting to intra-molecular transposition—



The product cannot on the present view retain its generally accepted name of dibromacetonitril, its carbons being detached. Its conversion into bromopicrin and cyanogen bromide by excess of bromine in alkaline solution is as intelligible as the formation of bromopicrin by hypobromite in other cases,—



one atom of bromine replacing an atom of oxygen, and by thus leaving three-fourths of the combining power of the carbon to the nitrogen causing this to leave the other oxygen to the other nitrogen. Thus we get cyanogen bromide. Then the oxygen displaced by bromine acts in the form of hypobromite as an oxidising agent on the NO, changing it to NO₂, the second atom of bromine combining with the carbon now only a quarter united to nitrogen.

(To be continued.)

OBITUARY.

WALTER WELDON, F.R.S., &c.

It is our most painful duty to put on record the unexpected death of one of the most distinguished and successful technical chemists, not in this country alone, but in the entire world. Walter Weldon, F.R.S., expired at his residence at Rede Hall, Surrey, on Sunday, September 21st, after a short but painful illness. His death is the more to be regretted as he was only in his 53rd year, having been born October 31st, 1832, and as he was actively engaged in researches having for their object the production of hydrochloric acid from calcium chloride. How far these investigations had progressed we are at the moment unable to say.

Every chemist is of course familiar with the general features of the "Weldon" process for the regeneration of the manganese peroxide used in the generation of chlorine, and with the consequent revolution in the production of bleaching-lime affecting favourably such important industries as the cotton and paper trades. It may be well for those who would discourage invention and inventors to remember that this one improvement has effected a saving in this country alone of £700,000 per annum.

The Weldon process was first tried on a practical scale about 1866 in the works—now demolished—of the Walker Chemical Company, near Newcastle. It was then continued and finally perfected at St. Helens, in Lancashire, in the works of Messrs. J. C. Gamble and Sons.

Our deceased friend was a Fellow of the Royal Society, a Vice-President of the Chemical Society and of the Institute of Chemistry, and a Past President of the Society of Chemical Industry.

In France he had received the Order of the Legion of Honour, and the "Grand Medal" of the Société d'Encouragement, an honour which has been conferred upon only four other persons,—Lesseps, Boussingault, H.

Ste.-Claire Deville, and Giffard. In presenting him with this medal, the late illustrious Prof. J. B. Dumas congratulated him on having "cheapened every sheet of paper and every yard of calico made in the world."

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 9, Aug. 31, 1885.

Octahedra of Sulphur with a Square Base, the Base of which is Physically Rhombic.—Ch. Brame.—On condensing upon a plate of glass the vapour of small drops of melted sulphur, remote from each other, we obtain a deposit of vesicles without a trace of crystals. At ordinary temperatures we see appear first among the vesicles incomplete crystals but having a tendency to form octahedra with a square base; then, after some days of exposure to the sun we distinguish fine octahedra with a square base isolated, or *encyclides*.

No. 10, September 7, 1885.

Researches on Isomerism in the Aromatic Series: Action of Alkalies on Phenols with Mixed Functions.—M. Berthelot.—In this paper the author contends that thermo-chemistry throws new lights on the constitution of the phenols and the other benzoic derivatives, enabling us to recognise the character of the so called isomers of position and to distinguish contiguous substitutions,—i. e., those effected in one and the same molecule of the generating acetylen (ortho series) from the substitutions effected in two distinct molecules (para- and meta-series).

Fluorescence of the Rare Earths.—M. Lecoq de Boisbaudran.—The author gives a summary of his results as compared with those obtained by Crookes, and which will be inserted in full at an early opportunity.

Moniteur Scientifique, Quesneville.

Vol. xv., August, 1885.

Notes on Chemical Industry in England.—An account of the methods at present followed for the production of chrome-green, tin-crystals, nitric acid, and arsenic acid.

Contribution to the Study of the Explosions caused by Dust.—C. Engler.—The author has investigated the conditions of the explosions which occur from time to time in the lamp-black works of the Black Forest. He finds that a mixture of air and of a gaseous hydrocarbon in which the latter is too small in proportion to be ignited becomes capable, when charged with charcoal dust, not merely of propagating flame, but of effecting true explosions. Air containing 2½ volumes per cent of marsh-gas takes fire throughout its entire mass if it is charged with charcoal dust, whilst air containing 3 to 4 per cent without the charcoal dust cannot be ignited, and only produces a limited local explosion with 5½ to 6 volumes.

The Incrustations of Bronze Statues.—The author's experiments show that treatment with potassium cyanide followed by washing with abundance of water is the best agent for removing spots. To prevent their formation he recommends attention to the surface of the moulds and to the polish of the statues.

Observations on the Conversion of Coal into Coke and on the Accompanying Volatile Products.—H. E. Armstrong.—From the CHEMICAL NEWS.

Regeneration of Sulphur from Vat Waste, and on a New Model of a Furnace for the Preparation of Chlorine by Means of Magnesium Oxychloride.—Walter Weldon.—A communication made to the Newcastle Section of the Society of Chemical Industry.

Comparative Trials of the Value of Tartar Emetic and Antimony Oxalate as Mordants.—G. Hirzel.—The author finds experimentally that the oxalate gives less satisfactory results. The shades obtained with the latter with methylene blues, steam blues, and alizarin reds, are duller and have less body. They are also more liable to spots and unevenness.

Oxygenated Water: its Preparation and its Uses.—W. Lindner.—The author states that the success of the preparation from barium peroxide depends on the care which is taken and on the purity of the reagents. The barium peroxide must be as pure as possible and in a very fine state of subdivision. Impurities, even in small quantities, are opposed to the preparation of a rich peroxide. This peroxide is stirred up in water, repeatedly washed to eliminate barium hydroxide, and finally passed through a very close wire sieve (at least eighteen meshes per centimetre). The product is laid on a filter, and stirred up with water to the consistence of paste. To decompose the peroxide he employs hydrofluoric, fluosilicic, or phosphoric acid,—generally the two latter. Oxalic acid yields a product as rich, but less stable. The peroxide paste is slowly introduced into acid suitably dilute, taking care to keep the temperature below 20°, and to stir carefully, so as to prevent the barium peroxide from coming in contact with portions of the liquid already neutralised which would be decomposed at once.

Patents taken in Berlin.—A list of specifications of German patents.

Patents in the Chemical Arts obtained in France.—Titles of patents taken out during the months of May and June last.

Selection of Patents obtained and published in France in 1885, in connection with the Chemical Arts.—Here also is a list of patents obtained during May and June last.

On Cocaine.—A. Bignon.

On Pheno-resorcin, and on its Applications in Surgery.—Dr. Augusto.—These two papers have merely a medico-pharmaceutical interest.

Industrial Society of Mulhouse.—Chemical Committee; Session June 10th, 1885.—A memoir was handed in, from M. Pelgrain, on the bleaching of animal and vegetable fibres by means of oxygenated water. For woollens he steeps the cloth in a solution at 12 vols. of oxygen, diluted with 20 vols. of water, and mixed with 5 to 10 per cent of sodium silicate at 20° B. M. Kœchlin employs in preference—

Oxygenated water at 12 vols. . .	1 litre.
Water	2 litres.
Silicate of soda, at 20° B. . . .	200 grms.

A more efficient but costlier mixture is—

Oxygenated water at 12 vols. . .	1 litre.
Water	1 „
Silicate of soda, at 20° B. . . .	50 grms.

Steam for two minutes in Mather and Platt's machine. The whites are finer than those obtained by stoving, and the fibre is less attacked.

Review of Foreign Chemical Researches.—Extracts from the *Berichte der Deutsch. Chem. Gesellschaft*, and from *Liebig's Annalen*.

Foreign Reviews on Colouring-matters.—Extracts from the same sources.

—
Justus Liebig's Annalen der Chemie,
Vol. ccxxix., Part 3.

On Certain Derivatives of Levulic Acid.—L. Wolff.—On distilling levulic acid very slowly in a spe-

cially modified apparatus it is almost entirely resolved into two isomeric neutral compounds of the formula $C_5H_6O_2$. These compounds, α - and β -angelicalactone, are to be regarded as unsaturated lactones which contain 2 mols. of water less than does valerolactone. These two compounds and certain of their derivatives are described at considerable length.

On Sodium Orthovanadates and their Analogues.—H. Baker.—The author describes the orthovanadates with 12 mols. of water, with 10, which exists in two modifications (forming respectively regular and hexagonal crystals), and with 8 mols. of water, as also the sodium vanadate fluoride.

Communications from the Organic Department of the Chemical Laboratory at Aachen.—These consist of the sixth and seventh chapters of an investigation into the compounds of the elements of the nitrogen group with the radicles of the aromatic series, by A. Michaelis. The sixth chapter treats of triphenylphosphine and certain of its derivatives, and the seventh on the anilides of orthophosphoric acid.

The Behaviour of Nitrotoluidines with Reducing Agents.—Dr. F. Graeff.—The author describes here hydrazo-aniline oxalate, hydrazo-acetanilide, the behaviour of various nitrotoluidines with sodium amalgam and with zinc powder in presence of alcoholic potassa, azoxytoluidine, its sulphate and hydrochlorate, toluenyldiamine and its sulphate, cresol-diamine and its sulphate; azotoluidine, its sulphate, hydrochlorate, and hydrobromate; hydrazo-toluidine, its sulphate, hydrochlorate, and hydrobromate.

On Azobenzol-thiosulphonic and Azobenzol-sulphinic Acids.—Dr. R. Bauer.—A series of details which do not admit of useful abstraction.

On so-called Isophloridzine.—H. Schiff.—Rochleder has pronounced the phloridzine obtained from the leaves of the same tree to be distinct from that procurable from the root-bark of the same tree, and has given it the name of isophloridzine. The author, after examining the points of distinction brought forward by Rochleder, finds them indecisive.

—
Cosmos les Mondes.

No. 28, Aug. 10, 1885.

Electrolytic Manufacture of Aluminium.—L. Senet.—A current of 6 to 7 volts and 4 ampères is caused to act upon a saturated solution of aluminium sulphate, separated by a porous septum from a solution of sodium chloride. A double sodium and aluminium chloride is formed and is then decomposed, and the aluminium liberated is deposited on the negative electrode.

An Electric Plant.—If a stem of the *Phytolacca electrica* is broken the hand receives a shock like that given by an induction coil. The magnetic needle is affected at the distance of 6 metres. The energy of the action has its maximum about 2 p.m., and declines during the night. It is especially increased during storms. Neither birds nor insects settle upon the plant.

No. 29, August 17, 1885.

The number of lightning strokes in Saxony has been found to increase regularly during the last 23 years. The annual cases from 1859 to 1862 were 67; from 1863-66, 81; and from 1879 to 1882, 189. The destruction of the forests is supposed to be one of the causes of this alarming increase.

No. 30, August 24, 1885.

Poisoning by Cheese.—At a recent meeting of the Michigan State Board of Health (July 14), Prof. Vaughan communicated a report on poisoning-cases due to sophisticated or putrescent cheeses. The cheeses made in factories are less apt to produce illness than those prepared

at farms and in private houses. The symptoms occasioned closely resemble those resulting from the ingestion of stale fish. Dr. Vaughan recommends for the detection of such cheeses a violet test-paper which is completely decolourised by the cheese.* (The preparation of this test-paper is omitted.)

The Magnesium Light.—M. Graetzel has succeeded in producing pure magnesium electrolytically at a price much below those which have recently prevailed.

Bulletin de la Société Encouragement pour l'Industrie Nationale. 3rd Series, vol xii., July, 1885.

Determination of Phosphoric Acid.—E. Aubin.—This memoir has been already inserted from its original source, the *Comptes Rendus*.

Bulletin de la Société Chimique de Paris.
Vol. xlv., No. 2, July 20, 1885.

This issue contains no original memoirs.

MISCELLANEOUS.

Gold Medal, Inventions' Exhibition.—We find from the *London Gazette* Supplement, p. 3773, that a Silver Medal has been awarded by the Jury of the Inventions' Exhibition to Mr. Watson Smith, F.C.S., F.I.C., for "Investigations relating to the Simon-Carvès Coke-Oven Process for Recovering By-Products."

Another H₂S Apparatus.—When the ordinary arrangements of the laboratory are disturbed, the following simple method of making H₂S will prove useful:—Take a test-tube about 5" × ½ containing a few fragments of FeS, fill it to about one-third with diluted H₂SO₄ (1:4), place it in a narrow 4 oz. beaker containing the water or solution to be saturated with H₂S, and invert over it a wider test-tube of equal length, so that the mouth of the latter is at the bottom of the beaker. The wider tube receives the H₂S, and discharges it slowly in large bubbles which spread through the liquid and are easily absorbed, so that scarcely any odour is perceived till the liquid is saturated. No wash-bottle is required, since the splashing in the inner tube never pass its border.—C.L.B.

Medical Education in New South Wales.—In the Medical School at Sydney University there are now twenty-three students for graduation in medicine and surgery—a number which may be considered very fair after only two years' existence of the school; seeing also that every medical student must have passed one year in arts before entering the school. Great progress has been made in the way of organising the different teaching agencies connected with this school, and considerable additions have been made to its special library and to the museums and scientific apparatus in the different departments. In the Prince Alfred Hospital, which is by statute and by its position on land surrendered by the Senate for the purpose, specially connected with the University, arrangements have been made for the teaching of medical students in accordance with the University curriculum and time-table. The direct authority given by statute to the University with a view to clinical instruction in this hospital is considered of essential importance to the efficiency of the Medical School. It is hoped that future regulations may make all hospitals enjoying State aid available as places for instruction, under suitable regulations. In response to applications made by the Senate, the General Council of Medical Education and Registration in the United Kingdom has recognised the Sydney matriculation examinations as qualifying for registration. It has also been arranged that the Royal College of Surgeons of England will exempt from examination in the medical subjects such of the Sydney graduates as may go up for the M.R.C.S.; while the University

of London has placed the Medical School of the University on the list of institutions which it recognises. The University of Edinburgh in like manner has agreed to accept three years spent in the Sydney School as equivalent to three years spent in its own school. In each case the maximum of privileges has been conceded.

NOTES AND QUERIES.

** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Production of Kelp.—Can any of your readers tell me where I can get reliable information as to the best and most approved means for the production of kelp from seaweed?—SPECIAL.

THE "YOUNG" CHAIR OF TECHNICAL CHEMISTRY, ANDERSON'S COLLEGE.

PROFESSOR—EDMUND J. MILLS, D.Sc. (LOND.), F.R.S.

SYLLABUS—SESSION 1885-86.

THIS Chair has for its object the instruction of Students in Chemistry as applied to the various branches of industry in Chemical and other works, Metallurgy, Agriculture, &c.

LECTURES.—Principal Course.—A Course of Twenty-five Lectures will be delivered on Mondays, Tuesdays, and Wednesday, at Ten a.m., commencing on November 2nd. This Course is specially intended for Manufacturers and Inventors, and will be illustrated with Experiments, Diagrams, and Models, as well as by the actual Inspection of Manufacturing Processes. Fee, One Guinea.

Subsidiary Course.—A subsequent Course of Thirty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at Ten a.m. These Lectures are more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalter, and others interested in a knowledge of TECHNICAL ORGANIC CHEMISTRY.

Fee for the Course, Two Guineas.

Evening Courses.—Professor MILLS will deliver a special Evening Course of Twenty-five Lectures on OILS, PAINTS, and VARNISHES, commencing on October 19th, at 8 p.m. These Lectures will qualify for the May Examinations of the City and Guilds of London Institute. For further particulars see special Prospectus.

EVENING PRACTICAL CLASSES.—There will be Practical Evening Classes in the following subjects, viz.:—OILS, PAINTS, and VARNISHES; BLEACHING, DYEING, and PRINTING; IRON and STEEL; and WATER SUPPLY and SEWAGE. The assistance of this Chair is placed at the disposal of all classes of Students of Technical Chemistry; and any person will be eligible for the Practical Evening Class who is desirous of learning, of improving his learning, or of perfecting some invention in any branch of Technical Chemistry. Fee for the Course of Twelve Lessons, Two Guineas.

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.—The requisite courses of instruction for the Associate-ship of the Institute can now be undertaken at Anderson's College, which has been admitted to the Register. For detailed information application may be made to Professor MILLS.

LABORATORIES.—The Laboratories are open daily throughout the year from 10 to 4, and on Saturday from 10 to 1 o'clock, for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months, or £2 10s. per Month. Students must have a fair acquaintance with elementary Chemistry.

The new Laboratory Buildings comprise four stories, with a Lecture Room in the rear, and are exclusively devoted to the purposes of this Chair. There are Five Private Laboratories for the use of Patentees and Inventors.

Further information may be obtained of the Professor, at the Laboratory, Anderson's College, 60, John Street.

Assis ant.—Mr. C. ELLIS, F.C.S.

ALEX. MOORE, C.A., Secretary.
Glasgow, 209, West George Street,
September, 1885.

BOROUGH OF STOCKPORT.

APPOINTMENT OF ANALYST.

The Council desire to receive applications from persons possessing competent knowledge, skill, and experience to undertake the duties of Public Analyst.

Applications, stating age, experience, qualifications, and terms, should be sent under cover, addressed "Appointment of Analyst, Town Clerk, Stockport," not later than 12 noon of Monday, 5th October next.

By Order,

WALTER HYDE, Town Clerk.

THE CHEMICAL NEWS.

VOL. LII. No. 1350.

ON THE DEVELOPMENT OF TECHNICAL INSTRUCTION IN METALLURGY.

By Prof. W. CHANDLER ROBERTS, F.R.S.,
Chemist of the Mint and Professor of Metallurgy in the Royal
School of Mines, London.

THE New School of Metallurgy which has recently been added to the Birmingham and Midland Institute was formally opened on the 24th of September, when a very large audience assembled in the principal lecture theatre of the Institute. The Mayor of Birmingham (Alderman Martineau) presided, and introduced Prof. A. Chandler Roberts, F.R.S., who delivered the following address:—

The opening of the newly organised Class of Metallurgy in this well-known Institute is another important step in the technical teaching of the country, and I have accepted the invitation of the Council to deliver a brief address on this occasion with much pleasure, for more than one reason. I recognise in the efforts your Council are making to foster technical instruction in this special subject the realisation of views I have long held; and, further, the lecturer, Mr. Hiron, by whom the metallurgical instruction here has now been conducted for some years, is my friend, and was a student of my own at the Royal School of Mines. I am anxious, therefore, to wish him success on entering on a more extended sphere of usefulness. In a circular which has been addressed to the manufacturers of Birmingham your Council has stated its conviction that:—

“A more complete course of metallurgy than has hitherto been possible here cannot fail to exert a great influence on the trades of the town and district, and it is hoped that by making workmen better acquainted with the scientific principles on which their trades are based, it will be possible to battle more successfully with our foreign competitors, who, in many respects, have the advantage of us in the superior scientific training they have received.”

While we admit that this is true, it may be well to remember a caution given by an old writer, W. Carnwise, in 1583, who held that judgment was more to be commended in recognising the skill of certain foreign artificers and craftsmen than in ignoring the ability, or, as he called it, the “activity” of our people, “who,” he says, “owte of all p’adventure be as skylull in myning, as hard and dyligent laborers, and as good chepe workmen in that kind of travell as are to be found in Europe.”

It is not a little strange that the systematic instruction in metallurgy in this country, to which the metal industries are all-important, should be of comparatively recent date. We appear to have imitated the system of the early metallurgists and alchemists (and for their work I can hardly claim too much respect), who handed down their traditions and discoveries through one or two pupils, for we find the master and disciple system surviving with singular vitality into recent times.

It is well known, especially in Birmingham, that metallurgy has progressed in two ways; first, by the technical skill of the craftsmen leading them a long way in advance of theory to the acquisition of important facts; and, second, by discoveries resulting from the application of purely scientific methods of procedure. The German miners and smelters introduced into this country by Queen Elizabeth were skilled craftsmen; but still the greatest advances in theoretical metallurgy were, even until quite recent times, the result of individual and not collective teaching. For just as in the 13th century Albertus Magnus had S. Thomas Aquinas for his pupil, both being

metallurgists, so in the 17th century Becher, who lived in this country and smelted tin here, transmitted to his famous pupil Stahl the theory of Phlogiston, which was mainly built up on a metallurgical basis, and the effect of which, both on scientific and technical progress, was so marked. Towards the end of the 18th century, what is now called technical education was pleaded for by an accurate metallurgical writer, Bishop Watson, Professor of Divinity at the University of Cambridge, who strongly insisted on the importance of the purely economic side of our subject, and who urged that the improvement of metallurgy and other mechanic arts dependent on chemistry would best be entrusted to an “Academy, the labours of which should be devoted to that particular purpose.” In my opinion, from the time 1782, when this wise prelate wrote, to the foundation of the Royal School of Mines in 1851, there is no event affecting the systematic teaching of our subject of anything like equal importance to the appointment of Dr. Percy as the first holder of the Chair of Metallurgy there.

I have elsewhere attempted to trace the development of the metallurgical work of the country to their origin in Dr. Percy’s labours. The evidence of their value is clearer to me now than when I delivered my introductory lecture at the School of Mines five years since, and the sense of the importance of Dr. Percy’s influence will, I trust, deepen as my own experience grows. We must, however, devote ourselves now chiefly to the progress that has been made quite recently. The results of the investigations of the Select Committee appointed in 1868 to enquire into the Provisions for giving Instruction in Theoretical and Applied Science to the Industrial Classes will be familiar to many of you, and the importance of the question in relation to metallurgy has been specially recognised by the Lords of the Committee of Council on Education, who, in 1882, took what was, from our point of view, the very important step of directing that metallurgy should be taught, as far as might be possible, *practically* to the students who present themselves for the May examinations. I am glad to be able to claim that the school we open to-night was, under the guidance of your Council, mainly the outcome of the action of the Science and Art Department; which is now, I am satisfied, making full provision for the primary instruction in metallurgy of foremen and artificers throughout the country, a view which is well borne out by the results of the examinations I have recently conducted. Its direct influence on the higher teaching of metallurgy I will endeavour to trace later on.

The advantages of technical education which the pressure of necessity is now slowly forcing on the country are so generally appreciated in Birmingham, that I need only dwell on the special claim of metallurgical teaching to the support of all who are interested in the great industries of the town. While it is unnecessary for me to justify the scientific teaching of the subject, it is perhaps more important than ever that the true relation of theory and practice should be clearly understood; and here considerations based upon the dual character of our work, that is, its practical and its scientific aspects, again present themselves. There are many metallurgical operations in conducting which the highest success can alone be secured by the subtle skill of sight or touch and the power to deal with new and unfamiliar conditions which education might impart to workmen would appear almost to diminish rather than increase the usefulness of those entrusted with certain definite operations. My earliest impressions on this point were gathered in Birmingham, the principal works of which I visited sixteen years ago, together with the late M. H. de Jacobi of St. Petersburg, whose name will be familiar to you, as he was one of the earliest workers in the field of electro-metallurgy; and I then learned how many men there are carrying on routine work with wonderful exactness, yet their only school was the workshop, and not the lecture-room or laboratory. It may, however, be urged that even such practical men of the high order of merit I am contemplating, should at least

know certain scientific facts by which their practice may be supported; and no less an authority than Jules Simon, formerly Minister of Public Instruction in France, has said, "The practised eye and the sure hand are worth much, but they do not replace science. The smith, who knows the disadvantages of too rapid oxidation, who understands why throwing water on the surface of ignited fuel increases the heat of the centre of the mass; the puddler who takes into account the effects of a reducing flame, and who employs it or an oxidising flame at will; such men are evidently the most important workmen, more skilful for current needs, less disconcerted by an accident, less embarrassed by having to describe an operation, less slaves to routine, quicker to adopt a new process." He adds, "but without speaking of the daily details of work, of accidents guarded against, or of remedies improvised, is it nothing, that by training workmen properly an impulse is given to the genius of discovery? It is sometimes necessary to separate practice and theory because life is short, but they should always be combined when possible because life is complex. It is necessary to join practice with theory, as in another order of ideas it is necessary to unite capital and labour, because one only sees a problem thoroughly by looking at both sides of it." The more intelligent the workman becomes the more he will appreciate the ability of those who direct him. He will, as the result of education, take keener interest in his work, and his social position will be materially improved, even though his daily wage is not augmented.

I cannot trace to-night the methods that are adopted on the Continent to ensure the efficient training of artificers and foremen; the literature of technical instruction is now abundant enough, and I must refer you to the various reports which have from time to time been published; but permit me say that in the laboratories you will presently visit and in the appliances and arrangements which have been provided by the Council, you have an admirable equipment, and in my opinion the Midland Institute is in a position to carry out with high efficiency the kind of instruction which is contemplated. The question now naturally presents itself, what evidence or probability is there that the education to be provided will be advantageous in the sense that it will 'pay,' which of course is the object of all improvement in conducting metallurgical operations. I do not want to multiply references to authority, but let me once more appeal to the Bishop, Dr. Watson, to whom I have referred as being one of the first to plead for systematic technical instruction. He said, a century since, "there is a certain standard of perfection in the exercise of every art which is not always well understood, . . . and he who should apply himself to the solution of the problem (the extraction of the greatest possible quantity of metal from any particular kind of ore) . . . must take into consideration another circumstance of as much importance as the quantity of metal to be extracted,—the expense attending the operation."

In estimating the advantage of special technical instruction in metallurgy, it is necessary to bear in mind the two characteristic features of the art of extracting metals from their ores and fitting them for industrial use. First, the history of metallurgy abounds with instances showing that an apparently trifling improvement in an operation, or, it may be, in the composition of an alloy, has been followed by large pecuniary gain, the amount of which would seem to be out of all proportion to the scientific merit of the discovery which led to the change. A suggestion gathered in the laboratory may prove a source of wealth when developed in the works, and it will be the special duty of the teachers who will so soon attack the comprehensive syllabus of the practical classes to indicate the direction in which improvements may be made, and to suggest the nature of the changes to be introduced into practice.

The second prominent feature of metallurgy to which I would allude is the enormous influence exerted on a large

mass of metal by a trace of another metal or metalloid;—that is, by a quantity so small that it appears to be out of all proportion to the mass in which it is distributed. I might adduce instance after instance in support of this point, but it is unnecessary to do so. Workers in the precious metals in Birmingham well know how small a trace of impurity will render gold alloys brittle; and, conversely, it is equally well known that the addition of a very small amount of certain metals to nickel will convert a very brittle mass into a perfectly malleable and ductile one. Electro-platers are familiar with the consequences which may result from a slight change in the composition of a depositing-bath. Or, to turn to less familiar points, I think you would be surprised if it were possible to show you some experiments I have recently made on the effect on the tenacity of certain alloys when the surface tension of wires, into which the alloys were drawn, is released by touching the wires with a mild pickling solution. Consider, again, what a large portion of the vast field presented by metallic alloys remains entirely unexplored, and how substantial the rewards of discovery in this direction are. In Birmingham what may be called the mechanical side of metallurgy is specially important, as the industries of this town are so largely devoted to working metals, and not to extracting them from their ores. The laboratories here are specially arranged in view of this fact.

It will be of the utmost importance to show the way in which preventible waste in conducting mechanical operations on metals may be reduced to the narrowest possible limits, by vigilant individual efforts, and to point to the advantage a careful workman has over one who is less attentive, though not less skilful.

It will be interesting to watch the effect of the establishment of this and other classes in the industrial centres, in enabling the higher instruction in metallurgy to be developed; and as Birmingham will, I trust, continue to furnish many Exhibitioners to the Royal School of Mines, at South Kensington and Jermyn Street, it may be well for me to endeavour to indicate what is, and should be, the nature of the instruction offered in Schools of Mines generally.

To take first our own School of Mines, which for more than thirty years has provided technical instruction in metallurgy and mining. Since its establishment in 1851 it has trusted to elaborate lectures, and has devoted special care to a complete system of laboratory work. The *Ecole des Mines*, in Paris, adopts a system which is in the main the same, but the students visit and report upon works during their vacation,—a plan I have endeavoured to imitate since my appointment to the chair at the School of Mines in 1880. *Sécond*, there is what may be called the System of Freiberg, as it is so well represented at the great school in Saxony, where the men study metallurgy theoretically, in lectures to which a somewhat limited laboratory course is added, the great feature of the instruction being the facilities the men have for spending a portion of each day in the Halsbrückner Hütte or the Muldner Hütte, these being the great works of the district in which the school is situated. And, finally, there is the system adopted in America, especially at the School of Mines, Columbia College, New York, and at the Massachusetts Institute of Technology at Boston, where, in addition to laboratory work as ordinarily understood, students carry out metallurgical operations, more or less experimentally it is true, but, as an engineer would say, on a scale of nearly "twelve inches to a foot."

It is somewhat difficult to compare the relative merits of these apparently distinct systems, because the conditions of the countries in which they are in force are so different. In London, Paris, New York, and Boston the Mining Schools are situated at some distance from metallurgical centres. From an American point of view the distance of London from S. Wales, Lancashire, and Yorkshire must seem insignificant; but distance is not the only difficulty to be met. In this country the works are not under Government control, and students therefore

owe their admission to works to the generosity of the owners, which has hitherto been so liberally exercised in the case of my own students that the absence of State influence has not been felt. On the Continent the control of works by the Government enables students to visit the various establishments as a matter of right, and this fact has doubtless determined the situation of certain Mining Schools. Although no strict comparison can be made, the following appear to me to be the prominent points connected with the three systems. Our own school was established at a time when, as we have seen, the systematic teaching of metallurgy in this country had been neglected. It was only natural, therefore, that extreme importance should be attached to laboratory work, and especially to researches having for their object the investigation of obscure points in metallurgical practice. There is, in fact, far too great a tendency at the present day to lose sight of the importance, from an educational point of view, of basing the teaching of students on a thorough knowledge of the chemical reactions upon which metallurgical operations must depend, and on rigorous and minute chemical analysis. I can only repeat an earnest appeal of Sir F. Abel* to the younger chemists, not to under-estimate the value and importance, in reference to the advancement of Science, of the labours of the plodding investigator of analysis.

The wealth of results obtained by the investigations conducted by my distinguished master and predecessor, and above all by the success in all quarters of the world of our School of Mines men, affords an abundant justification of the plan which has hitherto been adopted: we have at least trained a body of accurate observers ready at all times to bring scientific reasoning to bear upon new sets of conditions.

With regard to the Freiberg system, its chief merit appears to me to consist in giving the student broad views as to practical details, if it does not familiarise them with the real difficulties of metallurgical work. I am always glad to receive students in my own class who come from metallurgical centres, but, on the other hand, in my opinion it is very easy to over-rate the advantage to be derived from placing the advanced students in the midst of works. No doubt a metallurgical atmosphere pervades the works, and there is much in the spirit of the student's surroundings, but the number of metals treated in any one district must necessarily be limited, while many processes of vast importance are wholly unrepresented. Surely, it may be urged, the frequent opportunities for seeing metallurgical operations must be of great benefit to the student; but consider how short a time a student, who is preparing for the higher branches of his profession, can possibly give to the purely theoretical work which he must get through. Such a student has no leisure in addition to that which should be set aside for exercise; and if he had leisure, I do not think he would be putting it to the best advantage if he were to devote it to looking on at a metallurgical operation conducted by someone else; and I believe that no system by which a student accompanies a demonstrator, or even a local foreman, to works, and only sees the successes and not the failures of other people's labours, really affords him adequate instruction.

I agree entirely with the remarks of my friend Prof. R. H. Richards, of Boston, upon this point. He observes "that large works cannot afford to spoil a furnace charge to show a student what happens from a little carelessness. A well-regulated establishment may go on for a long time without such a slip, and unless the superintendent is used to giving instruction, or takes pleasure in it, a student may be months at a works without finding out what the key to the success of the establishment is."†

In the American Schools of Mines plant of sufficient power is provided to render it possible to concentrate by

the ordinary dressing appliances no less than four tons of any given ore, and to treat the enriched product by suitable metallurgical process, adopting either "dry" or "wet" methods, or both combined, as the necessities of the case demand; and it may be added that the "plant" provided is sufficiently comprehensive to permit the adoption of very varied methods of treatment.

The foregoing is a brief sketch of the plan which is being gradually introduced into the Royal School of Mines. During the past session one student studied the extraction of gold from pyrites as practised at Grass Valley, California, and another extracted silver from its ore by pan amalgamation. Even in the metallurgy of iron much may be done by small appliances, and I am specially grateful to Mr. P. C. Gilchrist for having given to the School of Mines the small blowing engine and accumulator used by himself and the late Mr. Sydney G. Thomas in their well-known researches which led to the development of the basic-Bessemer process.

The experience I have already gained of this method of instruction has satisfied me that by actually conducting experiments on a large scale students realise more fully than in any other way the absolute dependency of metallurgy upon chemistry. The value of assaying, in controlling the results of their work, becomes evident, and the men learn, as Prof. Richards observes, "by their own experience that little losses taking place here and there and everywhere in their work mount up enormously in their final account of stock, and they are led to understand that failures in mines and works quite as often result from errors in judgment as they do from poverty of the deposits or defects in the processes adopted."

It will, I trust, have been understood that I have been speaking only of the training of a student; his career as a metallurgist can only be perfected in the works, because the manager has not only to deal with metals but with men.

We need never fear that by any amount of technical education we shall, by moulding men to the ideas of any particular school, set limits to the efforts of genius: the unexpected will happen in metallurgy in the future as in the past. Individual character will always assert itself, and the necessity for individual exertion will be as great as ever. We may help intelligence to do what it can; genius will do what it must.

Increased efficiency in the instruction in the industrial centres will directly influence, and will be reflected in, the teaching of the Royal School of Mines, so that, if only "for my brethren and companions' sakes, I will wish thee prosperity."

PLEA FOR THE EMPIRIC NAMING OF ORGANIC COMPOUNDS.*

By WILLIAM ODLING, M.A., F.R.S.

Stare super vias antiquas."

VERBAL translations of the structural formulæ assigned to organic compounds possess certain advantages as names for the several compounds. Thus, they are applicable to all organic compounds of which the structural formulæ are made out; they are the only sort of names applicable to complex isomeric compounds; and their use cannot be dispensed with wholly in the case even of less complex compounds. Notwithstanding these advantages, structural names constitute unsuitable names for general use, more especially as applied to fundamental hydrocarbons, alcohols, and acids. They are objectionable for this use by reason of their length, complexity, and want of ready indicativeness; by the circumstance of their being based on conceptions of chemical constitution of a kind pointed

* British Association Report, Plymouth (1877), p. 44.

† Paper read at the Wilkes-Barre meeting of the American Institute of Mining Engineers (1870).

* Abstract of a Paper read before Section B, British Association, Aberdeen Meeting.

out by experience as eminently liable to change; and by the further circumstance of their representing necessarily a one-sided and, so far, an untruthful notion of the bodies designated. Structural names, expressing other than a distorted view of the constitution of all but a few of the most simple of organic bodies, are impracticable by reason of their length and complexity. Hence, to avoid the distortion inseparable from the use of any single structural name for an organic body, the only expedient is the assignment to each body, in proportion to its complexity, of an indefinite number of structural names, a proceeding almost tantamount to not assigning it any particular name at all. Although from their number and complexity organic bodies can only be designated by names which do in some measure describe and characterise them, the primary purpose of a name is undoubtedly to designate, and not to describe. Accordingly, with a view to the prompt mental association of object with name, brief empiric names, based on the origin and properties of bodies, are, wherever practicable, to be preferred to structural names. As regards isomeric bodies, they may to a large extent be advantageously distinguished from one another by means of significant letters or syllables prefixed to the name common to the different isomers. But the suggested use of the particular letters α , β , and γ , each in a special sense; also a general resort to the particles hydro-, oxi-, and hydroxi-, as name components; and, more especially, the innovation of substituting the word "hydroxide" for the long-established word "hydrate" are practices open to grave objection.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from page 172.)

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
|| Following a date signifies publication discontinued.

145. RAPPORT ANNUEL SUR LES PROGRÈS DES SCIENCES PHYSIQUES ET CHIMIQUES présenté - - - à l'académie royale des sciences de Stockholm par J. Berzelius. Traduit du Suédois par Ph. Plantamour. 4 vols. 8vo. Paris, 1841-'44.

Continued under the title:

- [a] Rapport annuel sur les progrès de la chimie, présenté - - - à l'académie royale des sciences de Stockholm par J. Berzelius. Traduit du Suédois par Ph. Plantamour. 2 vols., 8vo. Paris, 1845, '46.

Cf. Annuaire des sciences chimiques; also Årsberättelse om Framstegen i Physik och Chemi; also Jahresbericht über die Fortschritte der physischen Wissenschaften.

146. RECHERCHES PHYSICO-CHIMIQUES. 3 nos., 4to. Amsterdam, 1792-'94.

147. RECUEIL DES TRAVAUX CHIMIQUES DES PAYS-BAS. Par W. A. van Dorp, A. P. N. Franchimont, S. Hooge-Werff, E. Mulder et A. C. Oudemans, Jr. 3 vols., Roy. 8vo. Leide, 1882-'84+

REMSEN, IRA.

See American Chemical Journal.

148. RÉPERTOIRE DE CHIMIE, DE PHYSIQUE, ET D'APPLICATIONS AUX ARTS. Contenant les traductions ou extraits des travaux qui se publient sur ces matières dans les pays étrangers, et de plus un résumé rapide des mémoires parus en France. Rédigé par Ch. Martin, sous la direction de Gaultier de Claubry. 1 vol., 8vo. Paris, 1837.

Continued under the title:

- [a] Répertoire de chimie scientifique et industrielle. Contenant les traductions ou extraits des travaux qui se publient sur cette matière dans les pays étrangers, et de plus un résumé des mémoires les plus intéressants parus en France. Rédigé par Ch. Martin, sous la direction de Gaultier de Claubry. 4 vols., 8vo. Paris, 1837, '38.

Continued under the title:

- [b] Répertoire de chimie. Mémorial des travaux étrangers. Rédigé par Gaultier de Claubry et Ch. Gerhardt. Deuxième série. 1 vol., 8vo. Paris, 1839.||

149. [A] RÉPERTOIRE DE CHIMIE PURE ET APPLIQUÉE. Compte rendu des progrès de la chimie pure en France et à l'étranger. Par Adolphe Wurtz, avec la collaboration de Chas. Friedel, Girard, LeBlanc, et A. Riche, pour la France; Williamson, pour l'Angleterre; Lieben, pour l'Allemagne; L. Schischkoff, pour la Russie; Rosing pour les pays Scandinaves; Frapollini, pour l'Italie. 5 vols., 8vo. Paris, 1858-'63.

Simultaneously with the above a section devoted to applied chemistry was published under the title:

- [B] Répertoire de chimie pure et appliquée. Compte rendu des applications de la chimie en France et à l'étranger. Par Ch. Barreswil, avec la collaboration de Daniel Koechlin, Hervé Mangon, Em. Kopp, de Clermont, pour la France; Knapp, Boettger, Sobrero, Rosing, Boutlerow, pour l'étranger. 5 vols., 8vo. Paris, 1858-'63.

In 1864 [A] and [B] were united and continued under the title:

- [a] Bulletin de la Société chimique de Paris. Comprenant le compte rendu des travaux de la Société et l'analyse des mémoires de chimie pure et appliquée publiés en France et à l'étranger, par Ch. Barreswil, J. Bouis, Ch. Friedel, E. Kopp, F. LeBlanc, A. Scheurer-Kestner et Ad. Wurtz, avec la collaboration de C. G. Foster, A. Girard, A. Lieben, A. Riche, A. Rosing, Thoyot, A. Vée et E. Willm. Nouvelle série. 42 vols., 8vo. 1864-'84+

150. RÉPERTOIRE DE PHARMACIE, DE CHIMIE, DE PHYSIQUE, D'HYGIÈNE PUBLIQUE, de la médecine légale et de thérapeutique; réimpression générale des ouvrages périodiques publiés en France sur ces sciences. 1 vol., 8vo. Bruxelles, 1842.

151. RÉPERTOIRE DE PHARMACIE. Recueil pratique. Rédigé par A. Lartigue. [From vol. III., by Bouchardat.] 29 vols., 8vo. Paris, 1844-'73.

Nouvelle série. 3 vols., 8vo. Paris, 1874-'76.

United with the Journal de chimie médicale and continued:

- [a] Répertoire de pharmacie et Journal de chimie médicale réunis. Dirige par Eug. Lebaigue. 14 vols., 8vo. Paris, 1876-'84+

Cf. Journal de chimie médicale.

(To be continued).

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

Professor W. Chandler Roberts, F.R.S.—The Queen has been pleased to grant to Professor W. Chandler Roberts, F.R.S., of the Royal Mint, authority to use, after his paternal name, the name of his uncle, the late Major N. L. Austen, J.P., of Haffenden and Comborne, in the county of Kent.

ON THE
ACTION OF CARBON MONOXIDE ON THE
CHLORIDES OF LEAD AND SILVER.

By ARTHUR G. BLOXAM.

WHEN in search of a method of making phosgene gas, which should be independent of sunlight, I found the following alternation to the usual method in "Gmelin's Handbook of Chemistry," ii., 326:—"Carbonic oxide gas passed over ignited chloride of lead or chloride of silver reduces the metal and yields phosgene gas (Göbel, *Four. Prakt. Chem.*, vi., 388). This statement occurs again under "Lead Chloride" (v., 146).

In "Watts's Dictionary of Chemistry," iii., 539, the same remark is made, and also on the authority of Göbel.

In Göbel's original paper (about 1832) the reduction of silver chloride by CO is said to be much easier than that of lead chloride.

I have no hesitation in asserting that this statement of Göbel's is incorrect, and am astonished that it does not yet appear to have been corrected.

Starting in all good faith that such a positive statement was true, although contrary to my preconceived ideas of the stability of these chlorides, I passed CO through melted lead chloride in a combustion-tube drawn out at intervals into constrictions to ensure better contact with the gas. The gas was bubbled slowly and the tube heated to bright redness, but without any phosgene being evolved.

I now set to work to prove that PbCl_2 would not lose weight in dry CO.

When heated to redness the chloride lost no weight in dry nitrogen, showing that it could be trusted not to sublime, *if the stream of gas were slow*. Dry CO was then substituted for the nitrogen, and it was found that 0.15 per cent of weight was lost in six hours in one experiment, and 0.001 per cent in one hour in another experiment.

Considering that PbCl_2 volatilises slowly in a rapid stream of gas at a red-heat, and that it has a tendency to form an oxychloride with any trace of oxygen in the gas, the loss of weight sustained in my experiments is too trifling to be noticed. When moisture was admitted into the nitrogen before it entered the tube, the lead chloride lost considerably in a very short time, HCl being produced.

Dry CO was next passed over silver chloride, heated to the softening-point of glass, for forty minutes: during this time 8.551 grms. lost 0.0005 gm. Different temperatures and different rates of passing the gas produced no difference in the results, the chloride suffering no further loss in weight.

It may, therefore, be safely concluded that the chlorides of lead and silver are practically unaffected by being heated in a stream of carbonic oxide.

King's College Laboratory,
London.

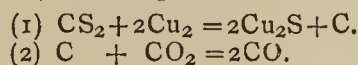
SOME REACTIONS OF CARBON DIOXIDE,
CARBON DISULPHIDE, AND SULPHUR DIOXIDE.

By ARNOLD EILOART, B.Sc.,
Daniell Scholar of King's College, London.

WISHING to make marsh-gas by passing CS_2 and SH_2 over heated copper, I happened to take as a source of SH_2 some sulphide of antimony, which I afterwards found to contain carbonate, and was surprised to find the bulk of my product to be CO. To get at the cause of this, which was evidently connected with evolution, from the antimony sulphide, of CO_2 , this gas was passed over red-hot copper. On introducing a tube of CS_2 so that the CO_2 carried some of the vapour through with it, abundance of almost pure CO was obtained. The temperature was near the fusing-point of the hard glass of the tube.

CS_2 alone passed over copper was decomposed below a red-heat.

The CO might therefore have been formed in either of two ways, viz., by two stages:—



Or at one stage, the reactions indicated by these equations taking place simultaneously, and not, at the temperature employed, successively. To test the former of these alternatives, copper, on which carbon had been deposited by decomposition of CS_2 at a red-heat, was heated in a stream of CO_2 . This gave slowly a small quantity of CO. In a second experiment as much as an ounce of CS_2 was decomposed, and CO_2 was passed over the copper. After about 50 c.c. of CO had been slowly formed the evolution of this gas almost ceased, and the experiment was stopped; but when the passage of the two compounds was simultaneous, other conditions remaining the same, the result was very different; many litres of CO were readily obtained.

As special care was taken that no more heat should be applied than in the former experiments, the inference from these results is that the nascence of the carbon from the CS_2 is a cause of the breaking up of the CO_2 group. But there is another cause: within the tube the temperature in the last experiment must have been higher than in the others, on account of the heat of decomposition of the carbon sulphide, and of the heat of combination of the copper sulphide. By omitting the copper this last source of heat was eliminated, with the result that the CO_2 was not broken up. CS_2 and CO_2 , carefully dried, were passed through a tube filled with bits of pumice, and the temperature was gradually raised till the tube was red-hot; but at no stage was there any formation of carbon monoxide, though the appearance of sulphur in the cool part of the tube showed the CS_2 was being decomposed.

It is interesting to observe now what happens when for the carbon dioxide is substituted sulphur dioxide,—less stable judged by the respective heats of formation. The SO_2 was prepared from bisulphite of soda by the action of strong sulphuric acid gradually admitted through a tap-funnel. It was found impossible to free the bisulphite completely from carbonate by passing SO_2 through it, even with boiling; but the CO_2 came off with the first portions of gas liberated by the H_2SO_4 , leaving the rest pure. This gas was passed through CS_2 , and thence through a drying tube and through a tube full of copper free from oxygen, and when air was expelled heat was applied. Below a red-heat carbon dioxide was formed, amounting, when the passage was slow, to half the issuing gas. Five per cent of this gas was carbon monoxide,—a secondary product resulting from the action of the CO_2 and the CS_2 in presence of copper, as is proved by the following experiment:—Carbon bisulphide vapour was passed over copper till air was expelled, and the copper was then heated for about two hours in a stream of the vapour, and allowed to cool without entrance of air. Sulphur dioxide was then passed till all bisulphide vapour was expelled, and on heating the copper, carbon dioxide was at once obtained, but no monoxide.

Next the copper was omitted. Carbon bisulphide and sulphur dioxide passed together through a tube containing pumice were decomposed at a higher temperature than when copper was used, but still below a red-heat. The gaseous product contained about 40 per cent carbon dioxide and 0.4 per cent of monoxide mixed with the SO_2 and CS_2 .

As it is mentioned in "Gmelin's Handbook" that charcoal heated in SO_2 gives CO_2 (with liberation of sulphur), it may be thought that these results were foregone conclusions: and this would be the case if the statement in Gmelin could be regarded as final; but particulars are not given. If the charcoal had not been freed from oxygen, it might, of course, give carbon dioxide without acting on

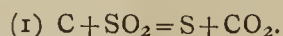
the sulphur dioxide; if the charcoal had not been freed from hydrogen, the action of this on the sulphur dioxide would account for the deposit of sulphur, water being formed.

To obtain results free from the doubts due to these possibilities the following experiments were made:—The carbon in a sample of charcoal was estimated, and found to be (I.) 72.9, (II.) 73.1 per cent (H 4.5 p.c., H₂O 5 p.c., and therefore O 17.5 p.c.). 0.100 grm. of this charcoal was raised to a moderate red heat in a stream of dry SO₂, and completely burned away. Air accidentally present had supplied 4 c.c. of oxygen for the combustion. This was estimated by collecting the nitrogen which passed through.

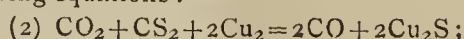
Carbon burnt in 0.100 grm., 0.073 grm.
Oxygen consumed by 0.073 grm. carbon .. 0.194 grm.
Oxygen in the charcoal, 0.0175 grm.
Atmospheric oxygen in the sulphur dioxide,
0.0055 grm. 0.023

Oxygen obtained by decomposition of SO₂. 0.171

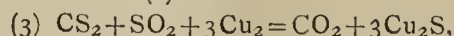
The experiment was repeated with a charcoal containing more carbon. On account of its porous nature the product of ignition of cane-sugar was used, as in the former experiment. It was heated ten hours in a gas-furnace in a stream of dry chlorine, and then contained 91 per cent carbon. It was then heated in a furnace fed with anthracite, having been placed in a porcelain tube, and through this tube chlorine was passed. This lasted ten hours. The product contained 97.5 per cent carbon. 0.085 grm. of this was heated in a stream of pure dry sulphur dioxide to near the fusing-point of the hard glass tube. This highly ignited charcoal yielded very slowly to the action of the SO₂, but at the end of ten hours it was found that only four and a half milligrams remained in the boat. Much sulphur had been formed. The issuing gas consisted (besides the excess of SO₂) almost entirely of carbon dioxide. There were, however, 6 c.c. of monoxide. There were also 12 c.c. nitrogen, which indicated that about 3 c.c. of atmospheric oxygen had been consumed. This is just the quantity of oxygen required to account for the 6 c.c. of CO. We may therefore represent the action of sulphur dioxide on carbon at a high red-heat by the simple equation—



The other results detailed above may be summarised in the following equations:—



and as corollaries of (1)—



and (4) CS₂ + SO₂ (passed over pumice heated below redness) = CO₂ + S₃.

ABSORBENTS FOR CARBON BISULPHIDE VAPOUR.

By ARNOLD EILOART, B.Sc.

In estimating the proportions of CO₂, CO, &c., in a mixture of gases, I have found some difficulty, when carbon bisulphide vapour was present, in getting rid of it. Caoutchouc cooled to -18° C. is said to stop the passage of this vapour; but a more convenient mode of absorption is desirable, and in order to find one, air saturated with CS₂ was passed through various absorbents at a rate of about one litre per hour. The absorbents tried were:—

Caoutchouc.—This effects only partial absorption.

Roll Sulphur Powdered.—Same result.

Iodine.—To be effective this must be followed by a guard tube for stopping iodine vapour; solid paraffin (which was coloured throughout by the iodine) was found best for this. At first complete stoppage of CS₂ vapour

was effected, but after three litres had passed the vapour began to escape.

Potassium Tri-iodide (with paraffin guard).—This completely purified 6 litres of air; then traces of vapour began to escape.

Strong Solution of Bromine in Potassium Bromide.—This allowed a little CS₂ to pass.

Linseed Oil.—This effected only partial absorption.

To purify gas in this way iodine would be the best substance: it absorbs a considerable proportion of its weight of CS₂ before allowing any to pass, and then it may be exposed to air in order that the CS₂ may diffuse and the absorbent be used again. But the difficulty of purifying large quantities of saturated gas in this way, without using excessive absorption apparatus, is obvious when we remember that one litre contains about one gramme CS₂, so high is the vapour-tension at ordinary temperatures.

The CS₂ was therefore removed after collecting the gas, by running the absorbent into the Crum's tube containing the portion to be examined. Used in this way linseed oil was found to be the best absorbent: it immediately absorbed the whole of the CS₂ vapour without dissolving CO₂, and was found to answer every purpose.

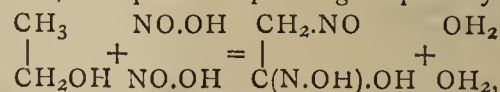
NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Prof. CHAS. E. MUNROE, U.S.N.A.

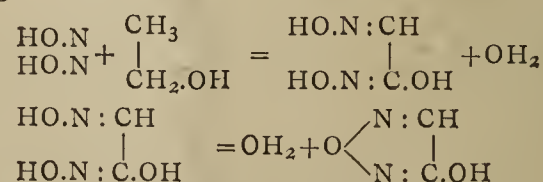
(Continued from p. 176.)

In a "Note on the Formation and on the Constitution of the Fulminates," (*Journ. Chem. Soc.*, January, 1884, page 25,) H. E. Armstrong states that the formula proposed by him was first publicly mentioned April 1, 1875, in the course of some remarks on Steiner's paper "On the Action of Ammonia and Sulphuretted Hydrogen on the Fulminates." His reasons for dissenting from Kekulé's formulæ are stated in "Miller's Elements of Chemistry," 3, 176, 5th edition. In proposing an alternative formula he was led to assume that half the nitrogen was present in the form of nitrosyl, NO, and the other half in the form of *hydroximide*, N.OH, because he took it for granted that the fulminates were the products of the direct action of nitrous acid upon alcohol, it being known from Victor Meyer's researches that both of these groups could be introduced through the agency of nitrous acid; the assumption that the fulminates were nitroso-derivatives also appeared to account for the formation of nitro-trichloromethane on distilling them with bleaching-powder, as it was known that certain nitroso-compounds were easily converted by oxidation into nitro-compounds.

But Victor Meyer's more recent researches have shown that the radical NO is not introducible into a CH₃ or CH₂ group by means of nitrous acid. The formula then requires modification, the equation expressing the primary reaction,



being thus far incompatible with our present knowledge as to the action of nitrous acid. Armstrong thinks Divers has made a similar mistake, since nitrous acid, and not its anhydride, must be the active agent, and therefore we may write his equation in the following manner without affecting the formula he deduces:—

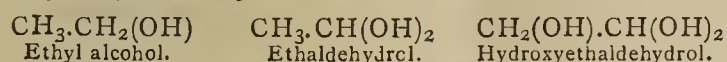


* From the *Proceedings of the U.S. Naval Institute*.

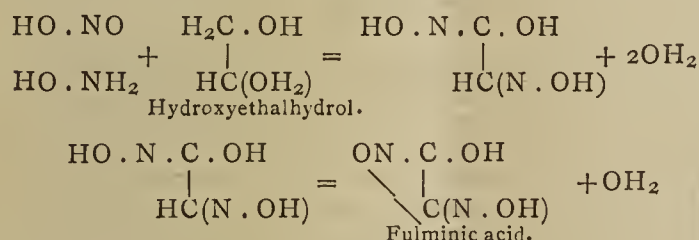
As it is proposed to continue these notes from time to time, authors, publishers, and manufacturers will do the writer a favour by sending him copies of their papers, publications, trade circulars, or expert testimony in infringement cases.

Here it is assumed that the CH_3 group exchanges 2H for N.OH; a reaction which is as entirely without precedent as that involving the exchange of H into CH_3 or CH_2 for NO under the influence of nitrous acid; the conversion of nitromethane into "methyl-nitrolic acid" might indeed be cited, but can scarcely be regarded as a parallel case.

Whatever may be the force of this objection, Armstrong propounds a different formula on what he considers higher grounds, viz., from a consideration of what is probably the nature of the reaction between alcohol, nitric acid, and mercury. In the first place, it is not probable that the fulminate is the immediate product of the action of nitrous acid, however produced, upon alcohol. It is well known that when treated with dilute nitric acid, alcohol undergoes hydroxylation, being finally converted into "ortho-oxalic acid," $\text{C}(\text{OH})_3$, $\text{C}(\text{OH})_3$, and Dr. Debus's classical research leaves little doubt that one by one the hydrogen atoms are displaced by hydroxyl; in this way the alcohol is converted first into "ethaldehydrol" ("Miller's Chemistry," 3, pp. 504, 715, 5th ed.), and then probably into "hydroxyethaldehydrol"—



He is inclined to regard this last-mentioned compound as the primary source of the fulminate which is formed from it by the simultaneous—or it may be consecutive—action of nitrous acid and hydroxylamine,—



That hydroxylamine may be formed by reduction of nitric or nitrons acid by ethaldehydrol, or more highly hydroxylised derivatives of alcohol, is in the highest degree probable, especially after Dr. Divers's recent communication on the production of hydroxylamine in the dissolution of metals in nitric acid.

The formula now proposed differs but slightly from that previously brought forward, but it is a far better expression of our knowledge of the fulminates. The representation of the carbon-atoms as exercising "triad" instead of "diad"* functions removes an obvious objection to his earlier formula.

According to Liebig (*Ann. Pharm.*, v., 287), fulminating silver separates in large needles and without the ebullition of the liquid, when nitrous acid is passed into an alcoholic solution of silver nitrate. Divers and Kawakita have repeated this operation, and give their results (*Journ. Chem. Soc.*, January, 1884, p. 27) under the title "On Liebig's Production of Fulminating Silver without the Use of Nitric Acid." There is an improbability of this reaction taking place, since it presents the first example of the displacement of the hydrogen of the $=\text{CH}_3$ group by isonitrosyl ($=\text{NO}-$), this having hitherto been effected only in the $=\text{CH}_2$ group; and, as another peculiarity, it presents an example of the formation of an isonitrosyl-compound by the action of nitrous anhydride in a neutral solution, instead of in a solution of nitrate at first alkaline and then made acid. It is not surprising, then, that they failed to verify Liebig's statement. They obtained the needle-shaped crystals, but found them to be silver nitrate mixed with a very small quantity of an organic silver salt. There was no fulminate. In fact their experiment in which silver nitrate, alcohol, and nitric acid were used, while no nitrous acid was present, gave the best yield of fulminate.

* These expressions have reference to the definition of valency which, following Lossen, represents that a radical is monad, diad, triad, &c., according as it is in direct association with either one, two, or three radicals.

Armstrong (p. 27) says of this, that the fact that nothing but an energetic oxidation of the alcohol, by a mixture of nitric acid and either mercury or silver nitrate, seems effective, is entirely in accordance with the view of the constitution which he states above.

From the similarity of copper to mercury and silver in its relations toward nitric acid, as recently discussed by Divers in his paper on "Hydroxylamine," the authors were led to make several trials to prepare copper fulminate from alcohol, and either copper nitrate and nitrogen trioxide; or copper nitrate and nitric acid; or copper nitrate, nitric acid, and nitrous acid, but all without success. The active catalytic oxidising power of cupric salts, which affects the action of nitric acid upon copper (Acworth und Armstrong), and so readily causes the destruction of hydroxylamine (or isonitrosyl hydride), is sufficient to explain the failure. In proof of its being exerted in this case, they state that when nitrogen trioxide is passed for some time into an alcoholic solution of copper nitrate, an abundant precipitation of copper oxalate is produced without any evident activity of the nitrous anhydride which all along becomes quietly absorbed by the alcohol.

Lieutenant John P. Wisser has translated for *Van Nostrand's Magazine* (xxx., 113, August, 1884) an article by Lieutenant Max von Forster, on "Experiments with Compressed Gun-Cotton." The first experiments to determine the efficiency of the explosive were made by placing the cartridges on lead cylinders, 46 m.m. in diameter (and of various heights), set upon small iron plates lying on solid ground. The wet gun-cotton (containing about 25 per cent of water) was detonated by dry gun-cotton primers, containing 1 grm. of mercuric fulminate, and these were fired partly by electricity and partly by a Bickford fuse. It was first remarked that the cartridges had a greater effect on the short cylinders than on the longer ones, and therefore only the results obtained with cylinders of the same length are compared together. (We may note here that it is not stated whether the cylinders were cast or drawn,* and that the system was not a rigid one.) On making this comparison for some nine experiments, where cartridges of various lengths were employed, the author concludes that in the case of dry gun-cotton no increased effect is produced by increasing the weight of the charge if at the same time the length of the charge is increased, for "it appears that in a long cartridge of dry gun-cotton the upper parts cannot transmit their detonation to the lower parts in the same explosive shock as that effected by the initial detonation of the primer, and hence it follows that in long charges of dry gun-cotton it is better to use several primers, placed some distance apart, and to fire them by electricity, in order to produce the greatest possible effect of the total charge."

When, however, gun-cotton containing 50 per cent of barium nitrate was used, it was found, in comparing cartridges of different lengths, that the effect increased with the weight in the longer ones, but not in a direct proportion, while with dry gun-cotton it diminished in this direction. With wet gun-cotton the effect was still greater than with the nitrated cotton, and it is held that in this substance the explosive wave is propagated with equal velocity throughout the entire length of the cartridge. The character of the impressions made on the cylinders also shows the more rapid action of the wet gun-cotton. Similar results were obtained with panclastite and Sprengel's mixtures. The author claims that these experiments confirm the statements of Abel in *Dingler's Polytechnisches Journ.*, 1874, in regard to the relative rapidity of the propagation of the explosive reaction in wet and dry gun-cotton, and he also extends the comparison to the effects produced.

In the article cited Abel held that "the more energetic action produced when gun-cotton and its preparations are detonated in a moist condition, has furnished the striking proof that the detonation is transmitted the more easily,

* *Proc. Nav. Inst.*, viii., 664, and ix., 288.

and the transformation of solid to gas and vapour takes place the more suddenly, the less the compressibility of a given explosive mass subjected to the action of a sufficient initial detonation. Since the water replaces the air contained in the compressed masses, the propagation of the detonation will evidently be favoured by the increased resistance which the particles offer during the instant of detonation." Lieutenant von Forster takes exception to this on the remarkable ground that wet gun-cotton is more easily compressed and less compact than dry, a proof given being that when dry compressed gun-cotton is to be re-worked it is first moistened in order to facilitate the crumbling. Having passed this criticism the author proceeds to re-state as his own, but in other words, the theory of Abel given above.

A most curious, and we believe entirely original, observation made in these experiments is the fact that when a piece of compressed gun-cotton is detonated on a plate of iron, an accurate impression of the form of the under surface of the gun-cotton is produced. Every angle, every projection, and every indentation present in the gun-cotton is impressed on the underlying iron. The author gives an explanation which is as novel as the observation. He holds that the gases produced have copied the form of the gun-cotton and transferred or transmitted it to the iron, "that the gases acting on the iron have occupied exactly the same space, and no more than the solid explosive previously occupied;" and hence he concludes "that only the gases evolved by the very undermost layer of gun-cotton act on the iron, while the others are lost."

Before meeting with this article of Lieut. von Forster's we saw similar impressions produced in iron by the detonation of disks of gun-cotton upon the iron,* but we supposed that, as the detonator was placed in the top of the disks, the impression was produced by the lower part of the disks being driven into the iron, just as any other resisting body interposed in the path of the explosive wave would have been. Of course we are met here by the difficulty that this hypothesis implies (1) that the pressure exerted upon the residual mass of gun-cotton is transmitted more rapidly than the explosive reaction is propagated within the mass, and (2) it also implies a great rigidity or coherency for this mass. The last condition is, however, a property of masses of matter when moving at great velocities, as is seen in the well known candle experiment, and in the cutting of steel by soft iron and the like. The difficulties presented in the first condition do not seem so great as those in Lieutenant von Forster's hypothesis.

From his observations on the effects of the exploding of gun-cotton in drill holes Lieut. von Forster concludes that its action is more sudden and local than that of dynamite, and he believes that the effect would be increased if we could give the gases of the detonated gun-cotton a fixed direction towards the object. In considering this problem he observes that the explosion takes place in a cartridge in the direction away from the detonating primer, and he finds a marked difference in the results of his experiments when the primer is placed on the end of the cartridge in contact with the target rather than on the end of the cartridge away from the target. He considers the simplest explanation of this fact to be "that the detonating gases of the primer form, to a certain extent, a dam, so that they offer from the beginning a resistance to the gases generated from the gun-cotton, and thus press them toward the other side. Even a very weak dam of loose earth acts on the gases of the explosive; why not the energetic detonation of the mercuric fulminate?" He also says that "this fact may be explained by the transfer of the vibrations of the gases of the primer to those of the gun-cotton, when the gases of the primer have a fixed direction." Lieut. von Forster states that the point in the cartridge at which the original direction of the gases is maintained has not yet been determined with certainty, but in his experiments the distance does not seem to be

very great; yet in the case of a cartridge of a weight of over double the diameter (*sic*), 70 : 30, the direction given by the initial detonation becomes quite noticeable. We, too, have observed the difference in effect due to the difference in the position of the primer, but had believed that it could best be explained by Berthelot's theory of the propagation of explosive reactions.

In addition to placing the primer on the side of the cartridge away from the object, the author proposes the use of a cartridge which is hollowed out on the end opposite the primer. In examples given, where cartridges of the same cross-section were exploded on iron plates, the hollow cartridges, although of less weight, produced twice the depth of impression that the solid ones did.

In the second part of his memoir the author treats of his method of rendering gun-cotton impermeable to moisture. Compressed wet gun-cotton has many inherent disadvantages. The water evaporates readily, and must be constantly renewed, though this difficulty may be greatly diminished by careful packing and storing; it crumbles easily, and even when well packed may suffer much in long-continued transportation; finally, it is subject to the action of a fungus which will in time destroy its structure. The presence of paper in the packages promotes the formation of this fungus and should be carefully avoided. To reduce these disadvantages the author proposes to dip the cartridges in some solvent, such as acetic ether or nitrobenzene, for fifteen to twenty seconds, then to take them out and allow the solvent to evaporate. A coating is thus formed on the surface which protects the cartridge from crumbling and prevents fungoid growth. Where an uncoated cartridge will dry in several days a coated one will require several weeks. Dry gun-cotton cartridges may be treated in the same way, but the author prefers to coat only the cavity for the reception of the primer by this means, and to coat the remainder of the cartridge with melted paraffin. An ingenious application of this invention is in its use for submarine mines, which will remain explosive for a certain fixed time, and after that time will become of themselves in explosive. This is effected by coating a cartridge so as to render it impermeable, and then slicing the coating off from the bottom. When immersed in water the liquid will gradually soak in until the whole is wet, and hence in explosive. The time required is dependent on the length, area, density, and composition of the cartridge. A cartridge of pure gun-cotton 100 m.m. high and of a density of 1.1 remains explosive for about 8 hours, while in 11 hours it is completely saturated and in explosive. A cartridge of gun-cotton mixed with saltpetre remains dry for a long time. A rubber tube may be used for protecting the priming.

In explosions under water it often happened to the author that, when the priming cartridge was adjusted by a copper lining, the gun-cotton charge began to burn or "to decompose into dense red fumes, nitrous acid fumes, &c., but did not detonate. This decomposition of gun-cotton into nitrous acid fumes, &c., by an insufficiently energetic initial detonation of the primer, appears not to have been elsewhere noticed." It seems to us that this observation is not new, though we cannot recall the reference, but we do find it recorded† that when gun-cotton burns from contact with a heated metal the oxides of nitrogen appear among the products.

In treating of the spontaneous decomposition of gun-cotton, the author says that he is in possession of a piece of compressed gun-cotton made in 1878, which was not completely washed, and in which some acid remained. The piece was preserved during this time in a chest kept in a dry place. It is now completely decomposed and has become a soft, greenish mass, which has lost the structure and appearance of gun-cotton, and when pressed yields a glutinous liquid. It smells sour, burns, when ignited, with a white flame (gun-cotton with a red flame), and

* "Sur la Force des Matières explosives," i., 73, 1883.

† "Traité sur la Poudre," E. Désortiaux, ii., 647, 1878, and "Die explosiven Stoffe," Böckman, 248, 1880.

* *Van Nostrand's Eng. Mag.*, xxxii., 8, January, 1885.

emits no appreciable vapours. No pressure has been observed in the air-tight preserving-jar, in which a part of this experimental prism of gun-cotton has been preserved since the decomposition began. This experiment shows that the spontaneous decomposition of gun-cotton may take place without the production of flame, and the author believes that a spontaneous combustion of gun-cotton has never occurred. Of course, gun-cotton subjected to high temperatures such as can only be brought about artificially, temperatures above 120°C ., is not included here. Good gun-cotton is pronounced sufficiently stable for all practical purposes.

How many unforeseen accidents may cause combustion is proven by the following experiment, communicated to the author by Prof. Kraut, of Hanover. If we take a good handful of simple cotton wadding, set a portion of it on fire, and wrap the other part around the kindled point so that the air is excluded, the piece of wadding may be wrapped in paper and preserved for months. If, at the end of this time, the wadding is unwrapped and air admitted, the part kindled months before goes on burning and consumes also the rest of the cotton. How often may this phenomenon have occurred when, in the case of the combustion of ordinary cotton, in large bulk, it was believed to be due to spontaneous combustion? With gun-cotton it is probably often the same.

We must refer to the original paper for the many drawings illustrating the experimental results.

The current press reports that Edison has proposed the use of a detonating mixture of hydrogen and oxygen for war purposes. He fixed two platinum wires, separated by a short space, in a thick glass tube; filled the tube nearly full of water, and then sealed it hermetically. The wires were then connected with a dynamo machine, the current made, and the water decomposed by electrolysis, by which means an enormous pressure was developed, which was sufficient to produce an explosion. He claims that this explosive is portable, cheap, and safe, since the glass and its contents are absolutely non-explosive until contact is made, and he proposes it for use in the place of powder, in guns, in blasting, and for torpedoes. For the latter purpose the tube may be buried in the ground, and after connecting the wires with a small battery the current may be so regulated as to explode it in a day, a year, or even ten years.

Under the title "Über die Analyse der Sprengstoffe," Dr. W. Hampe has reprinted from the *Zeitschrift für das Berg-, Hütten-, und Salinenwesen*, xxxi., 1883, a summary of the various processes proposed and in use for the analysis of explosive substances, to which he adds a method of his own devising. It is impossible to repeat the descriptions here without reproducing some of the many figures of apparatus which the pamphlet contains, and we must content ourselves with calling the attention of those who have such analyses to make, to the work.

To the courtesy of Captain Philipp Hess, of the Austrian Engineers, we are indebted for a copy of his report of the German Health Exhibition of 1883, under the title "Hygiene und Rettungswesen mit Bezug auf die Explosivstoff-Industrie." The topics treated of are: 1. General description of explosive substances; 2. Methods for analysing and testing the stability of Explosives; 3. The construction and arrangement of factories and magazines for explosives; 4. The precautions taken against the dangers inherent to the explosive industry; 5. The literature of the subject. This paper forms an excellent supplement to Hampe's, mentioned above, as it gives methods for testing in the laboratory the condition of stability of these substances. It is very full, too, in its descriptions of safety lamps, thermometric and electric alarms, fire-extinguishers, and the like, while it contains over sixty excellent illustrations of the apparatus and devices described. The pamphlet is a reprint from the *Mittheilungen u. Gegenstände des Artill.- u. Genie-Wesens*, and is dated Vienna, 1884.

(To be continued.)

NOTICES OF BOOKS.

An Agricultural Note-Book. By W. C. TAYLOR. London: Longmans, Green, and Co.

THE object of this book, as formally expressed on the title-page, does not commend itself very warmly to our sympathies. We there read that it is intended "to assist candidates in preparing for the Science and Art and other examinations in Agriculture," and accordingly we find more than one-seventh part of the space taken up with "questions for examination."

In Part I. we find mention of the "Science" of agriculture. The author evidently does not here mean the scientific principles upon which the art of agriculture is founded, but he views agriculture itself as a science, since he speaks of "its sister sciences, chemistry, botany, physiology." However, if such an authority as Whewell has utterly failed in impressing upon the British public the very plain distinction between Science and Art, further attempts are idle.

The bulk of the work consists of facts and truths expressed with the utmost brevity, and sometimes in language intelligible only to the author's pupils. Thus on page 2 we read:—"Temperature and water other two agents acting on the traitor's iron and potash, loosening particles from the hard rock." The italics in this obscure passage are the author's own. On the opposite page we are told that sand, as contrasted with clay, is "quickly impervious to water."

Among the diseases of corn we find enumerated the wireworm, the wheat midge, the Hessian fly, the thrips, the corn sawfly, the corn weevil, and the grain-moth; but there is no mention of the crane-fly or of the cockchafer, both very destructive in their larval condition.

In speaking of the effects of ground bones mixed with superphosphate, Mr. Taylor says, humorously but truly, "Improved as a manure, spoilt for analysis." This admission that chemical analysis does not in all cases show the real value of a manure is timely and judicious. Another specimen of humour is to be found in the lazy farmer's excuses for not attacking thistles early in the season.

That this little book is crammed full of the most valuable matter cannot be disputed, but we fear that, in virtue of its very conciseness, it will subserve cram among students, the facts and results here laid down being committed to memory with little regard to principles.

Gas-Engines. By W. MACGREGOR. London: Symons and Co. Edinburgh: Menzies and Co.

THIS volume belongs to the "Specialists' Series." The author declares that in manufactures where horse-power is required, not by the thousand but merely by the hundred, the gas-engine vies with the steam-engine in economy. But where only "tens and units of horse-power are employed in the smaller industries and in domestic requirements" the gas-engine has no rivals.

In his introductory sections the author sketches the history of these and analogous devices for obtaining mechanical power, from the powder-engine of the Abbé Hautefeuille, in 1678, to the Otto of the present day.

In his first chapter the author describes and discusses direct-working engines without compression, and shows that, in comparison with the "compression" engines subsequently described, they display radical inferiority.

Such compression-engines form the subject of the second chapter. He considers that the improvements in the Otto gas-engine made by Crossley Brothers are not changes in principle, but are substantially confined to the removal of mechanical difficulties. The efficiency of a gas-engine cannot be calculated by Carnot's formula, as the cycle in which it works does not even approximate to his theoretical cycle.

In the third chapter we have an account of compression-engines with a compression-pump, such as those of Wittig and Hee, Körting, Simon, Clark, the regenerative engine, and the compound engine. The arrangement in the Körting engine he considers superior to that of the Otto as far as regularity of action is concerned, but in default of comparative experiments he cannot come to a formal decision.

Some interesting remarks of Sir C. W. Siemens are quoted, to the effect that no unlimited degree of temperature can be reached by combustion. When a certain point has been attained,—about 1500,—dissociation comes into play, and both carbon and hydrogen refuse to take up oxygen.

The remaining portions of this work are devoted to theoretical considerations, according to Berthelot and Vieille, Witz, and Clerk.

Twenty-first Annual Report of the Alumni Association with the Exercises of the 64th Commencement of the Philadelphia School of Pharmacy for the Year 1884-5.

In this Report we find an emphatic denunciation of the secret remedy system, a nuisance which has reached a greater height in the United States even than in England. The writer does not, however, propose the safeguard which is required in both countries—the exclusion of medicines from the list of patentable subjects.

We regret to find in the Annual Class Oration a glorification of “emulation” as one of the guiding principles for the student.

Hay-fever formed the subject of a long discussion. Cases were brought forward to show that the pollen of flowers cannot be the efficient cause of the affection. One patient always suffered from an attack if buckwheat cakes were brought near. Another “was never able to go any wheres (*sic*) near a horse, not even within 6 feet of one, without being attacked by severe sneezing and asthma.” In some cases the disease does not disappear in the winter, whilst in others a sojourn in maritime localities effects no improvement.

In a lecture on diet and drink we find the very questionable statement that water in milk “can be detected by noting the specific gravity of the lactometer.” The speaker, Dr. J. M. Anders, must surely have forgotten that if the cream is removed from milk its specific gravity is increased, but on the addition of water it is brought back to the normal standard, this double fraud being quite incapable of detection by the lactometer.

Typographical errors are rather numerous throughout the book, especially in well-known proper names. Thus Mr. W. Mattieu Williams becomes in one passage W. Mattien Williams, and in another W. Matthew Williams. Dr. Thudichum becomes Dr. Thudichus, &c.

Mottershead and Co.'s Book of Chemical Labels. Revised Edition. Manchester: Mottershead and Co.

WE have here a set of labels clearly printed in bold type. The ordinary names are generally used, except where they might occasion confusion, and there is no attempt to introduce formulæ and synonyms. For substances which are in very frequent use, and are of a corrosive character, multiply labels are provided. As omissions we must note that molybdenum mixture has been overlooked, and that uranium is mentioned only in the free state. For general laboratory purposes these labels will be very useful.

Technical Vocabulary, English and German. By Dr. F. J. WERSHOVEN. Leipzig: F. A. Brockhaus. 1885.

UNLIKE the technological dictionaries and vocabularies that have been published during the last few years, the one before us is characterised by its small bulk, a feature,

however, which on an examination of its contents and the arrangement of the matter will not, it seems to us, detract much from its value. Indeed to put together a greater mass of really useful and every-day terms employed in technology into smaller compass would perhaps be difficult.

The contents are arranged in three chapters, beginning with Physics and Mechanics; then Chemistry and Metallurgy; lastly, with Machinery, Railways, Arts, and Manufactures.

In the chapter on Physics the names of instruments, their various parts, and the more common phrases likely to be used relating to these are given,—German and English,—in parallel columns, grouped under different headings, such as “Gravity,” “Lever,” “Atmosphere,” “Pumps,” “Thermometer,” “Light,” “Heat,” &c.

In the chapter relating to Chemistry a similar arrangement is adopted, beginning first with “General Notions,” “Names of the Elements,” “Nomenclature,” and “Apparatus,” going on to each individual element, its compounds, processes for the manufacture of the metals, furnaces, &c.

So likewise in the chapter on Machinery, Arts, &c., the German and English equivalents relating to machines in general are first given, with numbers of common phrases, followed with the several industries taken separately, as “Glass,” “Pottery,” “Sugar,” “Beer,” &c.

The smallness of this work, well adapted for the pocket, combined with its apparent completeness so far as relates to every-day use, will render it of much service among our technologists and chemists who, not being very proficient German scholars, require to consult German literature or to interpret English phrases into German.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 11, Sept. 14, 1885.

The Fluorescence of the Rare Earths.—Lecoq de Boisbaudran.—This paper will be inserted in full at an early opportunity.

On Certain Methylenic Derivatives.—Louis Henry.—The author describes methane biethyl-oxalate, methylene chlorobromide, and bromo-iodide.

On Panary Fermentation.—Aimé Girard.—The author's experiments prove that the essential phenomenon of panification, that which transforms the compact paste into a porous paste, accessible to the digestive juices, is the result of an alcoholic fermentation.

No. 12, September 21, 1885.

This number contains no chemical memoirs.

Journal de Pharmacie et de Chimie.
Series 5, Vol. xii., No. 4, August 15, 1885.

Extent of Alteration produced in Mercurous Iodide by the Action of Light.—M Yvon.—This salt on exposure to light for eight years turns almost black, and loses 0.72 per cent of mercury. A few crystalline grains of mercuric iodide are found adhering to the upper part of the bottle. The author proposes to apply the reaction of mercurous iodide and chloride with potassium iodide and bromide for the determination of these bodies. The particulars of his method will form the subject of a future communication.

Synthesis of an Acetone by means of an Acetylenic Carbide.—A. M. Béhal.—Cenanthol treated with

phosphorus pentachloride yields œnanthylen chloride. This compound, on treatment with alcoholic potassa in a flask fitted with a reflux condenser, yields œnanthylen chloride; and this again, on treatment with alcoholic potassa in a sealed tube at 140° to 150°, yields œnanthylen, the compound in question.

Determination of Morphia in Opium.—G. Doux.—The author modifies the extraction process used by Regnaud. He grinds the edge of a beaker with emery, puts into it 50 grms. of opium and 200 c.c. of alcohol at 70 per cent, and covers it with a disk of ground glass. He then places the beaker for twelve hours in a stove at 30°, stirring from time to time. He then lets it cool, and draws off 105 c.c., which exactly represents 25 grms. of opium. If the lid fits well there is no loss of alcohol. He then operates according to Regnaud's method, but he lets the precipitate form for thirty-six hours, instead of twelve hours as proposed by the latter. The results are slightly higher than those obtained by Regnaud's original process.

On a Molecular Combination of Phenol and Chloral Hydrate.—A. Bouriez.—The compound obtained is a colourless liquid, of sp. gr. 1.5, soluble in all proportions in water, alcohol, ether, and glycerin. It is resolved into its components by a slight rise of temperature, the chloral hydrate escaping, while the phenol remains.

Composition of Edible Swallows' Nests.—J. R. Green.—This substance is closely analogous to the mucine of Eichwald. If it is not a true saliva, it is a mucus secreted by adjoining glands.

The Absorption of Nitric Oxide by Ferrous Salts.—Jules Gay.—The quantity of nitric oxide absorbed by ferrous salts is independent of the kind of the salt, the degree of dilution of the solution, and is proportional to the weight of iron at the minimum of oxidation present, but varies with temperature and pressure. The law of this variation with pressure is neither that of compounds with a constant tension of dissociation, nor Dalton's law of the solubility of gases. The solubility of nitric oxide in ferrous salts approaches the law of the solubility of ammoniacal gases in water. The solution is entirely destroyed by a vacuum. It loses its gas, even in the cold, in any atmosphere free from nitric oxide.

No. 5, September 1, 1885.

New Process for the Rapid Detection and Determination of Nitric Acid in Air, Water, and Soils.—A. Grandval and H. Lajoux.—This paper (which is continued in No. 6, Sept. 15th), will be inserted at an early opportunity.

New Observations on the Chlorobromated Camphors. Production of Camphic Acid.—P. Cazeneuve.—Already noticed.

On Panification.—M. Balland.—Already noticed.

Action of Picric Acid upon Oil of Turpentine.—M. Lextreit.—If these substances are caused to react at about 150°, and if the clear liquid is then left to itself, crystals are deposited on cooling in warty masses. If freed from the excess of picric acid and from a brown colouring-matter, these crystals appear in slender, transparent, brittle laminæ: they are quickly affected by light, taking a pale yellowish orange colour, which gradually darkens. They are insoluble in water, sparingly soluble in cold alcohol. Ether and carbon disulphide dissolve them in abundance. If heated they melt, and are then decomposed with a slight deflagration. Picric acid behaves in the same manner with thymene.

Justus Liebig's Annalen der Chemie,
Vol. ccxxx., Part 1.

Para- and Ortho-phenyl-chinoline.—W. La Coste and C. Sorger.—This bulky memoir requires the accompanying figures.

Sulphallylic Acid and some of its Salts.—F. Szymanski.—We have here an account of the barium, strontium, calcium, copper, lead, magnesium, potassium, sodium, ammonium, and iron salts of this acid. These salts, if submitted to dry distillation, yield first a little allylic alcohol, and then a light oil having a garlic odour.

Sugar of Snow-berries (*Symphoricarpos racemosa*).—Dr. P. Herrmann and B. Tollens.—Snow-berries contain, along with dextrose and lævo-rotatory sugar, probably lævulose. The substance existing in solution in the sap consists, to the extent of three-quarters or four-fifths, of sugars, the remaining one-fourth to one-fifth being made up of albumen, gums, salts, and perhaps glucosides.

On Cupreine and Homoquinine.—O. Hesse.—Cupreine is a powerful base, which neutralises acids perfectly, forming neutral salts, which dissolve in hot water with a yellow colour. It forms also acid salts which yield colourless solutions. The author gives an account of the neutral and acid sulphates, hydrochlorates, double platinum salts, tartrates, and the neutral hydro-sulphocyanate. Cupreine combines also with inorganic bases, and with some of the bases connected with quinine, but not with ammonia. Dr. Hesse further examines the behaviour of cupreine with acetic anhydride, with concentrated hydrochloric acid, and with iodomethyl. The author shows that the homoquinine of Paul and Cownley is not a chemical individual, but a mixture of cupreine and quinine.

Studies in the Methylen-blue Group.—A. Bernthsen.—This important paper does not admit of useful reproduction.

Biedermann's Central Blatt für Agrikultur Chemie,
Vol. xiv., Part 3.

The Theory of Thunderstorms.—C. Liebenon.—Observations which the author has made by means of small balloons of a very small power of ascending make it appear probable that thunderstorms are always occasioned by ascending atmospheric currents. Such a mass of air saturated with moisture expands on ascending and is simultaneously refrigerated. A portion of its watery vapour is therefore condensed, and the latent heat thus set at liberty accelerates the upward movement. The precipitated drops of water are at first very small, and present therefore in their totality a large surface. They are therefore, in the first place, carried along by the particles of air impinging on their lower surfaces. On further condensation they increase in bulk, and fall down through the ascending currents of air towards the earth. Thus, as in Armstrong's steam-electric machine, a powerful friction is set up between the watery vapour of the ascending air and the falling drops. Hence the watery vapour becomes positively electrified, whilst the drops take a negative charge. The author explains the almost invariably positive condition of the atmosphere by the continued friction of the water dissolved in the air against the moist surface of the earth, the surface of the sea, and especially the drops of rain.

Occurrence of Combustible Carbon Compounds in the Atmosphere.—A. Muntz and E. Aubin.—From the *Comptes Rendus*.

The Influence of certain Salts on Nitrification in the Soil.—P. Richard.—Calcium sulphate—gypsum—has the greatest influence on the nitrification of organic nitrogen; next follow sodium and potassium sulphates, the former of these two being always the more effectual. The author explains the superior efficacy of the gypsum, notwithstanding its sparing solubility, by the circumstance that it is readily reduced in presence of organic matter and is as easily re-oxidised in contact with air, the process of nitrification being assisted by these changes.

The Use of Potassic Manures in Bretagne.—G. Lechartier.—From the *Comptes Rendus*.

The Loss of Nitrogen during the Fermentation of Farm-Yard Manure.—H. Joulie.—Gypsum is generally recommended as an addition to animal manures to prevent the loss of ammonia. From these experiments it appears, however, that the presence of gypsum is in every respect injurious. It increases the escape of ammonia and decreases the proportion of ammonia fixed in organic combination. An addition of calcium carbonate is in the highest degree injurious. Hence the presence of such substances as chalk and marl should be avoided.

The Use of Pommice as Cattle Food and Manure.—G. Lechartier.—The results seem to have been very satisfactory. If, however, rotten apples have been mixed with sound ones the pommice is reluctantly consumed by cattle.

Resorption, Formation, and Deposition of Fat in the Animal Body.—J. Munk.—The author finds experimentally that abnormal fats, such as rape oil, can be deposited in the body of a dog. The proof is that from the fat of the animal erucic acid was afterwards separated. Fats can be formed synthetically in the animal body from fatty acids and glycerin.

Occurrence of Amylase in Leaves.—L. Brasse.—From the *Comptes Rendus*.

Influence of Weeds on the Growth of Crops.—Prof. E. Wollny.—The author sowed various crops on similar plots of land, leaving the weeds in one and removing them in the other. The result was that the productive power of the cultivated plants was exceedingly lowered, both as regards quantity and quality. The injury was the greater the more slowly the plants were developed. Peas and summer rape suffered least; beans, maize, and potatoes were injured to the extent of 45 to 66 per cent; beets showed a loss of 97 per cent!

Researches on the Toxic Action of Arsenic, Lead, and Zinc on the Vegetable Organism.—Drs. F. Nobbe, P. Baessler, and H. Will.—Peas, oats, and maize, as also young alders and planes, in vigorous growth, were treated with potassium arsenite; the quantities applied to peas and oats were 0.003, 0.033, 0.333, and 1.0 gm. As per litre of the culture liquid, and to maize 0.0033, 0.005, 0.010, and 0.020 gm. The death of the plants ensued in a few days even in case of the smaller doses. An inquiry into the cause of death showed that the arsenic, in virtue of its action upon the protoplasm of the root-cells, annuls their osmotic power and thus prevents the absorption of water. The lower limit of the injurious action is not yet reached at one part per million. The quantity of arsenic actually taken up by plants is exceedingly trifling. If a plant is exposed for a short time only to the action of arsenic and is then restored to normal conditions the action of the poison is delayed, but morbid growth or death nevertheless occur. Experiments with lead and zinc showed that these metals, whether in the state of soluble nitrates or insoluble carbonates, are highly injurious to vegetation, even in such small quantities that the plants appear outwardly healthy.

TO CORRESPONDENTS.

Dr. Hicks.—We have no trustworthy details as to the extraction of papaine from the *Carica papaya*.

F. E. Stafford, Ferningham.—We have not met with any chemical apparatus made of the new phosphatic glass. The leading glass merchants would probably be able to inform you if it has yet found its way into trade.

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THE CHEMICAL NEWS.

VOL. LII. No. 1351.

ON THE SENSITIVENESS TO LIGHT OF SELENIUM AND SULPHUR CELLS.*

By SHELFORD BIDWELL, M.A., LL.B.

THE fact first announced by Mr. Willoughby Smith in 1873 that the electrical resistance of crystalline selenium is temporarily diminished by the action of light has been fully confirmed by subsequent experimenters.† Mr. Smith's original piece of selenium was in the form of a rectangular plate having electrodes of platinum wire fused into the shorter ends: others have used the substance in the form of rods or bars similarly furnished with wires. But since the effective action of light is mainly limited to the surface exposed to it, and since the specific resistance of crystalline selenium is always very high, various more or less complex arrangements have from time to time been devised for the double purpose of obtaining as large a surface as possible relatively to the volume of the selenium used, and at the same time reducing the distance between the electrodes to the smallest practicable limit. To these devices the name of "cells" is now generally given; but it will be convenient to include in this term any arrangement, however simple, in which two metallic electrodes are connected together by a mass of crystalline selenium.

Of the many investigations which have been undertaken in reference to this subject, by far the most valuable and exhaustive are those of Prof. Adams and Mr. R. E. Day, an account of which was published in 1876-7. From their paper in the *Phil. Trans.*‡ the following conclusions are abstracted:—

1. On exposure to light while a battery current is passing through it, the electrical resistance of a piece of selenium is apparently diminished. Experiments with a Bunsen flame, with weak sources of light and with moonlight, seem to show that this effect is due to the illuminating power rather than to the heating effect of the source.

2. The apparent change in the electrical resistance is directly proportional to the square root of the illuminating power of the light.

3. A slight increase of temperature of a piece of annealed selenium is accompanied by a large increase of electrical resistance.

4. There is, on the whole, a general diminution of resistance as the battery power is increased.

5. The first current sent through the selenium causes a more or less permanent "set" of the molecules, in consequence of which the passage of the current during the remainder of the experiments is more resisted in that direction than it is in the opposite one.

6. The passage of the current in any direction at any period of the series of observations produces a slight "set" of the molecules, which tends to facilitate the subsequent passage of a current in the opposite, but obstructs one in the same, direction.

* A Paper read before Section B, British Association, Aberdeen Meeting.

† Willoughby Smith, *Jour. Soc. Tel. En.*, ii., p. 31; Earl of Rosse, *Phil. Mag.*, March, 1874, p. 161; Sale, *Proc. Roy. Soc.*, 1873, p. 283; *Phil. Mag.*, March, 1874; Werner Siemens, *Phil. Mag.*, Nov., 1875, p. 416; Draper and Moss, *Chem. News*, xxxiii., p. 1; Adams and Day, *Proc. Roy. Soc.*, 1876, p. 113; *Phil. Trans.*, 1877, p. 313; C. W. Siemens, *Proc. Roy. Inst.*, 1876, p. 68; Sabine, *Phil. Mag.*, June, 1878, p. 401; Graham Bell, *Nature*, xxii., 500; Shelford Bidwell, *Proc. Roy. Inst.*, March 11, 1881; *Phil. Mag.*, April, 1881, Jan., 1883, and Aug., 1885; Fritts, *Elec. Rev.*, March, 7, 1885, p. 208.

‡ *Phil. Trans.*, vol. 167, p. 328.

7. After the current from a voltaic battery has been passed for some time through the selenium, and then the electrodes have been disengaged from the battery and connected with a galvanometer, a polarisation current in the opposite direction to that of the battery is found to pass through the galvanometer.

8. Under certain circumstances the action of light is capable of developing an electromotive force in pieces of selenium through which a battery current has never been passed. Currents due to this electromotive force are called by the authors *photo-electric* currents.

With regard to the action of light in producing these photo-electric currents, and also in diminishing the resistance of a piece of selenium through which a battery current is passing, Messrs. Adams and Day* have suggested the following explanation:—"Light, as we know, in the case of some bodies tends to promote crystallisation, and when it falls on the surface of such a stick of selenium, tends to promote crystallisation in the exterior layers, and therefore to produce a flow of energy from within outwards, which, under certain circumstances, appears in the case of selenium to produce an electric current. The crystallisation produced in selenium by light may also account for the diminution in the resistance of the selenium when a current from a battery is passing through it. For in changing to the crystalline state selenium becomes a better conductor of electricity."

Others of their observed results led them to the conclusion that selenium conducts electrolytically;† but it may be inferred from the paper—and was, indeed, expressly stated by Prof. Adams at the meeting of the Physical Society on June 13 last—that the authors did not suppose that actual electrolysis occurred, but rather that the molecular structure or crystalline condition of the substance was altered or modified by the action of a current of electricity in such a manner as to produce effects analogous to those which would have occurred if the selenium were an electrolyte and actually decomposed by the current.

As regards the effect of temperature, the authors' conclusion that a slight rise of temperature greatly increases the resistance of selenium appears at first sight to be inconsistent with the results obtained by Werner Siemens, Draper, and Moss, and others, who found that the resistance of selenium was diminished by heat. But Adams and Day appear never to have submitted their selenium to a higher temperature than 30° C., and some experiments of my own made with several different specimens‡ revealed the curious fact that selenium cells, whether in the dark or exposed to light, have a temperature of maximum resistance which is generally a few degrees higher than the average temperature of the air. The observations of Messrs. Adams and Day are therefore not necessarily inconsistent with those of others.

At the meeting of the American Association held last year at Philadelphia a paper was read by Mr. C. E. Fritts, descriptive of a new and very ingenious form of selenium cell, which is said to exceed any previously made, both in sensitiveness to light and in the power of the "photo-electric" currents which it is capable of generating.§ He melts a thin film of selenium upon "a plate of metal with which it will form a sort of chemical combination. . . . During the process of melting and crystallising, the selenium is compressed between the metal plate upon which it is melted and another plate of steel or other substance with which it will not combine. . . . The non-adherent plate being removed after the cell has become cool, [he] then covers that surface with a transparent conductor of electricity, which may be a thin film of gold-leaf. . . . The whole surface of the selenium is therefore covered with a good electrical conductor, yet is practically bare to the light which passes through the conductor to the selenium underneath."

* *Proc. Roy. Soc.*, 1876, p. 117.

† *Phil. Trans.*, vol. 167, p. 328.

‡ *Phil. Mag.*, April, 1881, and January, 1883.

§ *Proc. Amer. Assoc.*, 1884. Reproduced in the *Electrical Review*, March 7, 1885, p. 208.

Upon reading this description it occurred to me that the conduction of selenium when prepared in the form of cells might be in reality, and not merely in appearance, electrolytic. It will be noticed that Mr. Fritts spreads his selenium upon "a plate of metal with which it will form a sort of chemical combination." Now selenium will, I believe, combine more or less readily with all metals, the combination being assisted by heat. And in the preparation of selenium cells it has been the usual, if not the universal, custom to submit the selenium to prolonged heating while in contact with metallic electrodes. This operation has hitherto been called "annealing," and the undoubted fact that it diminishes the resistance of the selenium, and increases its sensitiveness to light, has been explained by supposing that the process is favourable to perfect crystallisation. I have recently suggested* as an alternative explanation that the prolonged heating, by promoting the combination of the selenium with the metal of the electrodes, results in the formation of a selenide, which completely surrounds the electrodes, and is perhaps diffused to some extent throughout the selenium when it is in a liquid condition; and that the apparently improved conductivity of the selenium, together with the electrolytic phenomena which it exhibits, are to be accounted for by the existence of this selenide. I found that while the specific resistance of the selenium contained in a good cell having copper electrodes was 0.9 megohm, that of a similar piece of selenium, annealed in a glass mould without contact with any metal was as much as 2500 megohms.† This enormous difference must, I think, be attributed to the presence of selenide of copper in the selenium of the cell.

I do not know whether, when the electrodes are of platinum, which was the metal used by Adams and Day, any appreciable quantity of selenide would be formed at the temperature employed for annealing. But a very small proportion of an electrolyte would account for the observed phenomena, and it is not impossible that a sufficient quantity might be contained as an impurity in the selenium as supplied by the manufacturer. Prof. Graham Bell, who collected various samples of selenium from different parts of the world, found, amongst other impurities, iron, lead, and arsenic,‡ all of which would form conducting selenides. He adds, it is true, that when these impurities were eliminated the selenium appeared to be more constant in its action and more sensitive to light; but it must be remembered that in constructing his cells he always melted the selenium upon electrodes of brass or copper. "All former experimenters," he says,§ "seem to have used platinum for the conducting part of their selenium cells, except Werner Siemens, who found that iron and copper might be employed. We have also discovered that brass, *although chemically acted upon by selenium*, forms an excellent and convenient material. Indeed, we are inclined to believe that the chemical action between brass and selenium has contributed to the low resistance of our cells by forming an intimate bond of union between the selenium and brass."

I am not sufficiently versed in chemistry to be able to submit the hypothesis here suggested to the test of direct experiment; but certain indirect evidence in support of my views has been forthcoming. Selenium is an element which in its properties closely resembles sulphur, and attempts have from time to time been made, hitherto without success, to develop in sulphur that peculiar sensitiveness to light which is such a remarkable characteristic of selenium. It occurred to me that if this property of selenium were really due to the accidental existence of metallic selenides, then the admixture with sulphur of metallic sulphides might be expected to lead to similar effects. Several cells were therefore constructed in which

selenium was replaced by sulphur containing a proportion of silver sulphide, the electrodes being formed of silver wire, and they all turned out to be more or less sensitive to light.* When one of these cells was connected in circuit with a battery and a galvanometer, and a piece of magnesium wire was burnt at a short distance from it, the galvanometer deflection was instantly increased, being in some cases more than doubled; and when the light was extinguished the deflection immediately fell to nearly its original value. If a telephone was substituted for the galvanometer, and the cell exposed to a rapidly interrupted beam of light, the telephone gave out a musical note, which was nearly as loud as that produced when a good selenium cell was used.

The resistance of most of these cells was diminished by heating, and a number of experiments were therefore made for the purpose of ascertaining whether the effects described above were due to the direct action of radiation or to the rise of temperature by which exposure to radiation is accompanied. It was conclusively proved that the direct action of radiation was in itself competent to produce the effects. First, the diminution of resistance due to light was instantaneous, while that produced by heating the cell was gradual. Secondly, the interposition of a glass trough containing a saturated solution of alum made no great difference in the result. Thirdly, a rise of temperature sufficient to produce any sensible effect could not possibly have been caused by the amount of light which was able to diminish the resistance in a marked degree. This was proved by the following experiment:—On a cloudy day the sulphur cell with the alum trough before it was placed at a distance of 16 feet from a small window, all the other windows in the room being darkened. With a battery of one Leclanché cell and a reflecting galvanometer, it was found that closing the window-shutter caused an instantaneous swing of the spot of light through 90 scale divisions in the direction indicating increased resistance; and when the shutter was again opened there was immediately an equal swing in the opposite direction. A delicate thermopile, connected with a galvanometer of low resistance, was then put in the place of the sulphur cell. On opening the window-shutter a deflection occurred, indicating a current which was found by trial to be equal to that produced by the radiation of the human body at a distance of 10 feet 6 inches. Now, a nearly red-hot brass rod held at a distance of little more than an inch from the cell produced a gradual fall of the resistance, which in fifteen seconds was indicated by only twenty-three scale divisions; and it is needless to say that the heat communicated by the human body at 10 ft. 6 ins. was entirely without visible effect. Lastly, in the case of one cell (which contained sulphur and silver sulphide in equal parts), light and heat produced opposite effects. A paraffin lamp at a distance of 18 inches diminished the resistance. When the lamp was placed at a distance of 10 inches, the galvanometer needle first moved in the direction indicating a further fall of resistance, but after a few seconds, when the temperature began to rise, it turned in the opposite direction. On moving the lamp to a distance of 4 inches from the cell, there was at once a large deflection indicating increased resistance, the temperature effect completely predominating over that of radiation.

When, as in the case of these cells, a current of electricity passes between silver electrodes through a mass of sulphide of silver, silver will be deposited upon the cathode and sulphur upon the anode. Now sulphur has an enormously high resistance, and the existence of a mere film of free sulphur upon one of the electrodes would be sufficient to stop the current altogether. The current is not in fact stopped, because the deposited sulphur at once combines with the silver of the anode, merely adding a new layer to the electrolyte. Thus the metal of the anode

* *Phil. Mag.*, August, 1885.

† This was the result of a single experiment. The properties of selenium sometimes vary so greatly under apparently similar treatment, that the conclusion should be received with caution.

‡ Paper read before the National Academy of Sciences, April 21, 1881.

§ *Nature*, xxii., page 502.

* Several different forms of these cells are fully described in a paper recently communicated to the Physical Society, and published in the *Phil. Mag.* for August, 1885.

gradually combines with the sulphur of the electrolyte; and the conductivity of the arrangement will depend to a great extent upon the facility with which this combination is effected, the quantity of electricity which can pass in a given time being limited by the quantity of sulphur which is capable of uniting with the electrode in the same time.

Sulphur combines with silver far more readily than with iron. If, therefore, my views are correct, we should expect a cell with an iron anode to offer a much greater resistance than one which had an anode of silver, the material of the cathode, so long as it was a good elementary conductor of electricity, being of comparatively little importance. To test this idea, a cell was made consisting of electrodes of iron and silver imbedded in a mixture of sulphide of silver and sulphur. The cell being connected with a battery and a galvanometer, it was found that its resistance was nearly thirty times as great when the current passed from iron to silver as when the direction of the current was from silver to iron.

It might therefore be expected that the resistance of a sulphur cell with silver electrodes would be diminished by any influence which assisted the combination of silver with sulphur. Experiment seems to show that such an influence is exerted by light.

A glass plate covered with silver-leaf was placed with the silvered side downwards over a crucible of boiling sulphur. One half of the unsilvered side of the plate was covered with a piece of black cloth, and the arrangement was exposed to bright sunshine. In a short time the visible portion of the silver was darkened, owing to its partial conversion into sulphide; the cloth was then removed, and the silver beneath it was found to be scarcely discoloured.

Since this effect might possibly have been due to other causes than the action of light (such as the unequal condensation of sulphur vapour upon the covered and the uncovered portions of the plate), the experiment was made in another form. A piece of silver-leaf attached to glass was brushed over with a solution of sulphur in bisulphide of carbon, and, in order to keep the temperature low and uniform, the silvered glass plate was immersed in a basin containing cold water, which was placed in the sunshine. A board was laid across the top of the basin so as to shade one-half of the plate, the other half being exposed to the direct rays of the sun. In a quarter of an hour the exposed portion of the silver had acquired a dark brown colour, while that which had been protected was of a pale yellow tint, the outline of the shadow of the board being sharply defined. I think we have here the strongest evidence that the combination of sulphur with silver is assisted by light.

But it is not perhaps necessary to assume that the effective action of light is confined entirely to the electrode. It seems reasonable to suppose that any circumstances which are favourable to the union of two substances when they have a tendency to unite would also be favourable to their separation when from any cause they have a tendency to separate. If then, as is commonly supposed, electrolysis involves a series of decompositions and recompositions, both these processes would be assisted by the same agency which under ordinary conditions favours the union of the constituents of the electrolyte. The electrolysis of silver sulphide may therefore be assisted by light, and its electrolytic resistance at the same time diminished.

All the sulphur cells hitherto mentioned were made with silver sulphide and silver electrodes. Silver was in the first instance chosen as being especially suitable for the purpose on account of the facility with which it combines with sulphur. A few experiments have since been made with copper and copper sulphide, but no indication of sensitiveness to light has yet been obtained with these materials, though I do not consider the results conclusive. But even if it should turn out to be the case that silver is the only metal which in conjunction with sulphur is capable of forming a combination sensitive to light, it would still, I think, remain probable that the action of light upon the

resistance of selenium, in conjunction with any metal whatever with which it formed a sensitive combination, is of a similar nature to that which occurs in the case of sulphur and silver.

ON HELMHOLTZ'S VIEWS ON ELECTROLYSIS, AND ON THE ELECTROLYSIS OF GASES.*

By Professor A. SCHUSTER.

PROFESSOR SCHUSTER explained some of the views expressed by Helmholtz in his recent papers on electric polarisation and electromotive force. The President of the Chemical Section has in his opening address already drawn attention to the bearing which these views have on chemical theories. The fundamental notion of Helmholtz consists in the assumption of a different attraction of chemical elements for positive and negative electricity. If this is admitted, the difficulties which have been felt in explaining electromotive force of contact disappear. In compound bodies like water the hydrogen is positively electrified; the oxygen, on the other hand, is charged with negative electricity. If an electromotive force acts on the liquid, the positively charged atom is driven to the negative pole, and the oxygen to the positive pole. This motion is called forth by any electromotive force, however small, and no work is done except that due to overcoming of the internal resistance. The positively charged hydrogen atom covers the negative electrode, but does not constitute free hydrogen. When the electromotive force is sufficiently strong an interchange of electricity takes place between the pole and the ion, and then only can the hydrogen separate out. A large amount of work has to be done to separate the positive charge from the hydrogen. In all decompositions where the elements separate out in a neutral state, it would seem, if these views are correct, that upon decomposition an interchange of electricity must take place. Thus, for instance, when aqueous vapour is dissociated by heat the oxygen must give up its free electricity before it can form neutral oxygen molecules. The conversion of stannic into stannous chloride, mentioned by the President, would have to be accompanied similarly by an interchange of a negative charge on the chlorine with a positive charge on one of the atoms of tin, leaving then both neutral chlorine and neutral stannous chloride.

With respect to the question of rates at which the ions travelled, Prof. Schuster thought Prof. Lodge had not laid sufficient stress on the remarkable result arrived at by Kohlrausch, that in dilute solutions, and for a given intensity of current, each element had its own rate of travelling, which was independent of the other ion: thus, the barium atom travelled at the same rate whether originally combined with chlorine or iodine. This result gave a very strong support to the views from which it could be deduced, and proved conclusively the different velocities of different ions.

Finally, Prof. Schuster explained his view of the electric discharge of gases, which in his opinion presented many analogies to the electrolytic conduction; or rather that called by Helmholtz electric convection. The peculiar phenomena surrounding the negative electrode as well as stratifications do not appear in the discharge through mercury vapour, and were probably due to a splitting up of the two atomised molecules at the negative pole. Phenomena of polarisation consequently appear at the cathode, but the ordinary methods of investigating these phenomena are not available in gases. Experiments which the author hoped to perform in the next few months will decide whether in the gaseous discharge each atom carries off, as in electrolysis, the same quantity of electricity.

* British Association, Section B, Aberdeen Meeting.

BARIUM SULPHATE AS A CEMENTING
MATERIAL IN SANDSTONE.*

By FRANK CLOWES, D Sc.

BISCHOF mentions instances of foreign sandstones in which the material cementing the sand grains together is barium sulphate, but it appears that up to the present time no such sandstone has been met with in the United Kingdom. Having learned from my colleague Professor Blake that opinions differed regarding the calcareous nature of certain New Red Sandstone beds in the neighbourhood of Nottingham, I undertook to examine the chemical composition of these sandstones.

At the spot in question the sandstone appears as two hills, known as Stapleford and Bramcote Hills, and in the intervening valley there is a pillar of rock called the Hemlock Stone. The hills are conical in shape; the Hemlock Stone is a mushroom-shaped pillar some twenty feet in height. Professor Blake visited the spot with me some short time since, and we procured specimens of the sandstone from different levels of the hills and of the Hemlock Stone. One of these portions was placed in the hands of two senior students for careful analysis, with the result that the sandstone was reported to contain about 30 per cent of barium sulphate. I have recently found that the whole of the sandstone specimens from the two hills already mentioned contain this sulphate in varying proportions, which are at present being determined with care, whilst some of the lower beds also contain calcium carbonate. Those geologists who collected their specimens from the lower portions of the Hemlock Stone would undoubtedly detect a carbonate by the ordinary test with an acid, and would therefore consider the sandstone to be calcareous; but if they had procured samples of the mushroom-shaped top of the stone they would have found no carbonate, and would have failed to detect by the acid test the true cementing material, which is barium sulphate. It seems probable that the protective cap of the pillar owes its comparative permanence against weathering action to the presence of a very large quantity of this almost insoluble sulphate.

In some of the sandstone beds the barium sulphate is very unequally distributed, forming a network or a series of small masses more or less spherical in shape: in such sandstone the sand grains between the sulphate streaks and patches is quite loose, the result being that the weathered surface presents a honeycombed or mammillated appearance. In one bed which caps the Bramcote Hill the barium sulphate is present in little isolated patches about the size of a hazel-nut, and the weathering of this sandstone accordingly yields little pebble-like masses of sand held together by the sulphate; this bed is accordingly usually described by the geologist as a pebble bed, although this name is not strictly appropriate.

I have attempted to detect some evidence of the way in which this barium sulphate has been introduced into the original sand-bed. It may possibly have been deposited together with the sand, but if this is its origin it has certainly undergone physical change, since it exists now in a firm, compact, and crystalline condition. It seems certain, therefore, that it has either been originally deposited from aqueous solution, or has been rendered crystalline by the slow percolation of a solvent liquid through the sedimentary deposit, or else that it has been formed by the action of water containing calcium sulphate percolating through sandstone originally cemented with barium carbonate.

This double decomposition between calcium sulphate and barium carbonate has been artificially carried out by Bischof, and the presence of calcium carbonate together with barium sulphate in some of the beds in question may indicate such an origin. With regard to the possibility of

barium sulphate being deposited from solution, or being rendered crystalline by a solvent, it must be remembered that barium sulphate stalaclites exist: the origin of these stalaclites is undoubtedly similar to that of ordinary calcium carbonate stalaclites, and one which I have recently examined consists wholly of the sulphate. I have also received sand-pebbles bound together with large and well-formed crystals of barium sulphate; and that such crystals have been deposited from solution and not from fusion has been demonstrated by Bischof almost beyond doubt.

ON CHROMIC PHOSPHATE.

By CHARLES L. BLOXAM.

WHEN employing Na_2HPO_4 for the separation of Fe and Cr from Co and Zn, the green precipitate produced by boiling an acetic solution of chromic oxide with sodium phosphate presented the appearance of a definite compound, and since I could find no mention of its composition, I have analysed it.

Sample 1 was made by acidulating a solution of chromalum with acetic acid, adding sodium phosphate, so as to leave the chromium somewhat in excess. No precipitate occurred till the solution was boiled for some time, when a bright green precipitate separated, leaving the solution of a green colour, but not further precipitated by boiling. The precipitate was washed and dried at 100° .

Sample 2 was made by reducing potassium dichromate with HCl and alcohol, precipitating with NH_3 , re-dissolving in acetic acid, adding sodium phosphate in slight excess, and boiling the dark purple solution, which soon became green, and deposited a dark green gelatinous precipitate, leaving a solution containing phosphoric acid, but no chromic oxide. This precipitate was washed by decantation and dried at 100° .

Even after prolonged washing both precipitates had retained considerable quantities of the alkaline salts from the solution; but as sample 1 was precipitated in the presence of excess of chromic oxide, and sample 2 in presence of excess of phosphoric acid, the ratio between these two constituents would fix the formula of the phosphate.

The second sample was much darker than the first, until it was finely powdered, when they were both of nearly the same colour. The chromic phosphate dissolved slowly when boiled with strong HCl. When heated over a Bunsen burner it evolved much steam, and became of a dark brown colour and insoluble in HCl.

When fused with Na_2CO_3 much of the chromic oxide was converted into sodium chromate. It was completely oxidised and dissolved by boiling with strong HNO_3 (1.4) and adding KClO_3 in small portions. The red solution was mixed with excess of NH_3 , and the phosphoric acid precipitated as MgNH_4PO_4 , which was ignited and weighed. The filtrate was acidified with HCl, reduced by boiling with sodium sulphite, and the chromic oxide precipitated by NH_3 . Even in the presence of a very large quantity of NH_4Cl , the chromic oxide carried down with it MgO, sometimes amounting to 13 or 14 per cent, so that it was necessary to re-dissolve it, after weighing, in HNO_3 and KClO_3 , and to estimate the Mg as pyrophosphate. The chromic oxide also carried down a considerable quantity of SO_3 , which was determined in the filtrate from the magnesium precipitate.

It was attempted to determine the chromium as BaCrO_4 by dissolving in HNO_3 and KClO_3 , adding excess of ammonia and excess of acetic acid, and precipitating by BaCl_2 , but the barium chromate brought down with it a large quantity of barium phosphate.

The following numbers were obtained in 100 parts:—

	Sample 1.		Sample 2.			
Cr_2O_3 ..	37.80	37.77	37.05	37.11		
P_2O_5 ..	34.30	34.40	33.40	33.33	33.52	33.25

* A Paper read before Section B, British Association, Aberdeen Meeting.

Calculating from the mean result in each sample, and omitting the water and adhering impurities, this would give—

	1.	2.	Theory (Cr ₂ O ₃ .P ₂ O ₅).
Cr ₂ O ₃	53'28	52'62	51'7
P ₂ O ₅	47'61	47'37	48'3

Hence the precipitate produced by boiling a solution of a chromic salt with sodium phosphate and acetic acid appears to be essentially the normal phosphate, Cr₂O₃.P₂O₅ (or CrPO₄), containing a slight excess of Cr₂O₃, and retaining about five molecules of H₂O after drying at 100°.

King's College London,
September, 1885.

ON SOME POINTS IN THE PHYSIOLOGY OF CERTAIN ORGANS OF THE ALIMENTARY CANAL OF *BLATTA PERIPLANETA*.

By Dr. A. B. GRIFFITHS, F.C.S., &c.

My object in this paper is not to describe the anatomy, or even the complete physiology, of the alimentary canal of *Blatta*, but rather to mention certain recent investigations of my own on various organs in that track which have not been thoroughly investigated before by naturalists.

(a) *Salivary Glands*.—In passing from the oral cavity towards the anus we first notice the salivary glands and their receptacles; they lie on each side of the œsophagus and crop. The secretion of these organs are alkaline to test-paper, and have the power of transforming starch into dextrose sugar, but has not the power of dissolving albumen. Further, the secretion gave indications of sulphocyanates and calcium, showing that the secretion of these glands of the cockroach resemble to a certain extent the secretion of the salivary glands of the vertebrata.

There is some evidence in the cockroach that there are terminations of the nerves, ending in these salivary glands; although they have never been made out in the glands of the higher animals, there is some probability they do exist in the higher forms of animal life. It may be that these nerve-endings in the salivary glands of *Blatta* effect the protoplasmic substance of the cell forming the ferment (probably ptyalin), which has the property of converting starch into sugar. So, from this, these organs are true salivary glands like those of the vertebrata.

(b) *Chylific ventriculus*.—In *Blatta* and insects generally there are three stomachs—crop, gizzard, and true stomach; the chylific ventriculus, or true stomach, is of a soft and delicate texture. Its secretion I have found to be slightly acid, and this acid property is due to the presence of hydrochloric acid, proved by the ordinary tests for that acid. It also contains a substance which has the power of dissolving albuminous substances, such as white of egg, casein, fibrin, &c., producing turbid solutions which are like the peptones produced by the secretions of the stomachs of the higher animals. This substance, from its various reactions, is similar to pepsin. The investigation proves that the chylific ventriculus is a true stomach.

(c) *Malpighian cæca*.—The functions of these organs have not been thoroughly established by naturalists,—some say that they are the “liver” of the animal, others say the “renal” organs. So far I have been able to ascertain that the secretions of the Malpighian glands contain uric acid and urea, for I have extracted crystals of both these organic substances from the glands in the same manner as in my researches on *Astacus* and *Anodonta*.

I intend to investigate these organs more fully at some future date. For those who wish to study the anatomy and histology of the alimentary canal of *Blatta*, I refer them to “Recherches sur les Phénomènes de la Digestion chez les Insectes,” par M. Plateau, 1874; “Unter-

suchungen über die chylopoietische und uropoietische System der *Blatta orientalis*, by Prof. Basch in *Sitzungsberichte der Wiener Akademie*, xxxiii. (1858).

Chemical Laboratories,
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A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from page 182.)

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
- || Following a date signifies publication discontinued.

152. *REPERTORIUM DER ANALYTISCHEN CHEMIE* für Handel, Gewerbe und öffentliche Gesundheitspflege. Redigirt von Skalweit. 8vo. Hannover, 1881+
153. *REPERTORIUM DER CHEMIE UND PHARMACIE*. Herausgegeben von Swittau. 8vo. St. Petersburg, 1837 (+?)
- REPERTORIUM FÜR CHEMIE*. Elwert.
See *Magazin für Apotheker*.
154. *REPERTORIUM FÜR DIE PHARMACIE*. Angefangen von Adolph Ferdinand Gehlen und fortgesetzt in Verbindung mit C. F. Bucholz, Rink und Anderen, von Johann Andreas Buchner. [From vol. v., unter Mitwirkung des Apotheker-Vereins in Baiern, herausgegeben von Johann Andreas Buchner.] 50 vols., 12mo. Nürnberg, 1815-'34'.
Zweite Reihe. 50 vols., 12mo. Nürnberg, 1835-'48.
Dritte Reihe. 10 vols., 12mo. Nürnberg, 1849-'51.

Continued under the title :

- [a] *Repertorium (Neues) für Pharmacie*. Unter Mitwirkung von Alb. Frickhinger, C. F. Hänle, J. E. Herberger, X. Landerer, Th. W. Ch. Martius, W. Mittenheimer, Friedrich Mohr, Max Pettenkofer, A. Schnizlein, F. L. Winkler, herausgegeben von J. A. Buchner. 25 vols., 12mo. Nürnberg, 1852-'76.].
Ergänzungsband. 1 vol., 12mo. Nürnberg, 1816.
155. *REPERTORIUM FÜR ORGANISCHE CHEMIE*. Herausgegeben von C. Löwig. 3 vols., 8vo. Zürich, 1841-'43.].
REPERTORIUM FÜR PHARMACIE. Buchner.
See *Repertorium für die Pharmacie*.
156. *REPERTORIUM FÜR PHARMACIE UND PRAKTISCHE CHEMIE IN RUSSLAND*; oder, Zusammenstellung des Wichtigsten und Wissenswerthesten aus den neuesten Entdeckungen im Gebiete der Pharmacie und Chemie mit vorzüglicher Rücksicht auf das russische Reich. Red.: C. Gauger. 8vo. St. Petersburg, 1842.
- 156 A. *REVUE HEBDOMADAIRE DE CHIMIE SCIENTIFIQUE ET INDUSTRIELLE*, publiée sous la direction de Ch. Mène. 7 vols., 8vo. Paris, 1869-'75.
157. *REVUE SCIENTIFIQUE ET INDUSTRIELLE des faits les plus utiles et les plus curieux observés dans la médecine, l'hygiène, la physique, la chimie, la pharmacie, l'économie rurale et domestique, l'industrie nationale et étrangère*. Sous la direction de Quesneville. 16 vols. (I.-XVI.), 8vo. Paris, 1840-'44.
Deuxième série. 15 vols. (I.-XV.), 8vo. 1844-'47.
Troisième série. 9 vols. (I.-IX.), 8vo. 1848-'51.
Quatrième série. 1 vol., 8vo. 1852.

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

Followed by :

- [a] *Moniteur (Le) scientifique du chimiste et du manufacturier. Livre-Journal de chimie appliqué aux arts et à l'industrie. Spécialement consacré à la chimie générale pure et appliquée, par Quesneville. 5 vols. (I.-V.), 4to. Paris, 1857-'63.*

Continued under the title :

- [b] *Moniteur (Le) scientifique. Journal des sciences pures et appliquées. Deuxième série. 7 vols. (VI.-XII.), 4to. Paris, 1864-70.*

Continued under the title :

- [c] *Moniteur scientifique—Quesneville. Journal des sciences pures et appliquées, compte rendu des académies et sociétés savantes et revue des progrès accomplis dans les sciences mathématiques, physiques et naturelles. Photographie, chimie, pharmacie, médecine, revue des inventions nouvelles et industrie manufacturière des arts chimiques. Journal fondé et dirigé par Quesneville, Troisième série. 14 vols., 4to. Paris, 1871-'84.*

(To be continued).

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Prof. CHAS. E. MUNROE, U.S.N.A.

(Continued from p. 187.)

M. PÉTRY has devised the following process for manufacturing the explosive paper which he calls dynamogen.† In an enamelled pot containing 150 grms. of pure water he dissolves 17 grms. of yellow prussiate of potash, and, when it is heated to boiling, adds 17 grms. of charcoal, stirring the mixture well together. Allowing the whole to cool somewhat, he adds, successively, 35 grms. of potash, 70 grms. of chlorate of potash, and 10 grms. of starch, triturated in 50 grms. of water. The whole is stirred so as to constitute a very thin paste, which is spread with a brush over ordinary filtering paper. The paper is dried upon a moderately heated plate, and the other side is varnished in like manner. After three coats have been laid upon each side the paper is dried. It can be cut without danger and made into cartridges.—*Chron. Indust.*, Jan. 1., 1883; *Four. Frank. Inst.*, [3] 86, 468, Dec. 83.

This recalls the "Explosive Paper" described as follows in *Boston Journal Chemistry*, ix., 112, April, 1875. Make a mixture of saltpetre, 8 parts; chlorate of potash, 5 parts; charcoal powder or pulverised coal, 1 part; fine sawdust of hard wood, 1 part; and a little mucilage, gum, or other binding material; put water enough on it to change it into a pasty mass, work it well through, and soak strips of heavy blotting-paper in it. If you dry these strips you obtain explosive paper; if you roll them up tightly when wet and let them dry, you obtain little blocks which, when confined and fired, will explode with great violence, but will not easily go off by percussion or friction alone.

Mr. C. John Hexamer‡ continues his discussion of the means for the "Prevention of Dust Explosions and Fires in Malt Mills" in the *Four. Frank. Inst.*, cxvi., 200, Sept., 1883, and describes several devices which he has invented for this purpose.

The *Bulletin of the Edison Electric Light Company*, No. 22, April 9, 1884, announces the installation of a 100-

light machine in the government powder mill at Spandau, Prussia.

At a factory in Neusalz a large cast-iron wash-kettle was used to hold water, into which melted iron was allowed to flow, in a moderate stream, for making iron shot. On October 23, 1882, one of the workmen, by mistake, allowed the iron to flow too rapidly. There was a sudden development of steam, which threw out a part of the water, frightening the labourer and causing him to drop his ladle, so that about 20 kilogrms. (44 pounds) of melted iron fell at once into the water. There was an immediate rapid outburst of steam and a loud explosion, which shattered the kettle into fragments, tore up the wood-work, threw the workman nearly eight feet backwards and broke his right leg. Only a very small piece of the kettle was found where it stood; some of the pieces were thrown to a distance of about fifty feet.—*Four. Frank. Inst.*, cxvi., 237, Sept., 1883; *Dingler's Poly. Jour.*, March 7, 1883.

In the first portion of these Notes attention was called to the growing importance to the student of explosives of the new study of thermo-chemistry, and frequent references have since then added force to this suggestion; but the elaborate work M. Berthelot, now before us, bearing the title of "*Sur la Force des Matières Explosives d'après la Thermochimie*," shows most strongly the necessity of conducting our inquiries into the constitution and mode of action of explosive substances from this standpoint, if we wish to arrive at any rational conclusions and to discover the general underlying principles. This work is in two large octavo volumes, of over 400 pages each, and bears the imprint of Gauthier-Villars, Paris, 1883, which is a guarantee of excellent typographical form and workmanship. The work is announced as a "third edition, revised and considerably augmented," but one would be at a loss to recognise the thin little duodecimo entitled "*Sur la Force de la Poudre*, 1872," as the second edition of this work.

Although in civil life, yet Berthelot has had unparalleled opportunities for the study of explosive substances; for in addition to having served as president of the Scientific Committee for the defence of Paris in 1870, and having been delegated to fill the place formerly occupied by Gay-Lussac upon the Advisory Committee on Powders and Saltpetre, he is President of the Committee on Explosive Substances, created June 14, 1878, where he has associated with him some sixteen specialists from the Army, Navy, and the corps of Mining Engineers and Engineers of Powders and Saltpetre (among whom we note Sarrau, Sebert, Cornu, Vieille, Desortiaux, and others), and in this position he has the assistance of a considerable laboratory force and all the resources of a highly centralised government at his command. It is then not surprising that, by April 5, 1883, his committee had completed twenty distinct researches, and had twenty-three others in course of execution.

The work now under consideration is based principally upon these researches together with those of Berthelot and others in pure chemistry. The first part deals with the general properties of explosive substances, their chemical composition, the heat disengaged in their explosion, and the pressure of the gases produced; the duration of the explosive reaction; explosions by influence, and the explosive wave. The second part treats especially of the thermo-chemistry of explosive compounds, a chapter being devoted to the much-vexed question of the origin of the nitrates; and the third part considers the force of the explosive bodies. The work is replete with descriptions of the apparatus used, the methods pursued, and the data obtained in these researches; but, as we have already noticed, in these Notes, many of the results as they have appeared in the professional Journals, we will simply present the tabular summary. (See Table at foot of next page.)

In citing these results of Berthelot's work, it may be proper to call attention to a recent review by Prof. Remsen,

* From the *Proceedings of the U.S. Naval Institute*.

As it is proposed to continue these notes from time to time, authors, publishers, and manufacturers will do the writer a favour by sending him copies of their papers, publications, trade circulars, or expert testimony in infringement cases.

† *Proc. Nav. Inst.*, viii., 449.

‡ *Proc. Nav. Inst.*, ix., 295.

TABLE* showing the percentage of Nitro-glycerin contained in the different grades of Atlas Powder, and the distinguishing marks of corresponding grades of "Hercules," "Giant," "Etna," "Hecla," and "Judson" Powders.

Atlas. (Standard.)		Hercules.		Giant.		Ætna.		Hecla.		Judson.	
Brand.	P.c. N.G.	Brand.	P.c. N.G.	Brand.	P.c. N.G.	Brand.	P.c. N.G.	Brand.	P.c. N.G.	Brand.	Per cent. N.G.
—	—	—	—	—	—	—	—	—	—	R.R.P.	5 and under.
F+	15	—	—	—	—	—	—	—	—	F.	10
E.	20	No. 4.	20	M.	20	No. 5.	15	—	—	FF.	15
E+	25	No. 4 S.	25	—	—	No. 4 X.	25	No. 3.	20	F.F.F.	20
—	—	—	—	XXX.	27	—	—	No. 3 X.	25	—	—
D.	30	No. 3.	30	—	—	—	—	No. 2.	30	—	—
—	—	—	—	No. 2 C.	33	—	—	—	—	—	—
D+	35	No. 3 S.	35	—	—	No. 3 X.	35	No. 2 X.	35	—	—
C.	40	No. 2.	40	No. 2.	40	No. 2.	40	No. 1.	40	—	—
C+	45	No. 2 S.	45	No. 2 Extra.	45	—	—	—	—	—	—
B.	50	No. 2 SS.	50	New No. 1.	50	No. 2 XX.	50	No. 1 X.	50	—	—
B+	60	No. 2 SSS.	55	—	—	—	—	—	—	—	—
—	—	No. 1.	65	—	—	No. 1.	65	—	—	—	—
A.	75	No. 1 XX.	75	No. 1.	75	—	—	No. 1 XX.	75	—	—

* "Atlas Powder," a Nitro-Glycerin Compound, p. 25, published by Repauno Chemical Co., Philadelphia, Pa.

Nature of the explosive substance.	Formula.	Molecular weights in grms.	Heat disengaged at constant volume by one kilogram. in calories.	Volume of permanent gas* per kilogram, in litres.	Specific pressure from experiments† (1 grm. in 1 c.m. ³) in atmospheres.	Velocity of the explosive wave per second, in metres.
Oxygen and hydrogen	H ₂ +O	18	{ 3833 liquid water 3278 steam* }	1240	11960	2810
Chlorine and hydrogen	H+Cl	36.5	603	610	4940	"
Carbon monoxide and oxygen	CO+O	46	1483	480	4510	1089
Ethane and oxygen ..	CH ₄ +O ₄	80	{ 2669 liquid water 2419 steam* }	840	11420	2287
Ethine and oxygen ..	C ₂ H ₂ +O ₅	106	{ 3001 liquid water 2907 steam* }	630	8630	2482
Ethene and oxygen ..	C ₂ H ₄ +O ₆	124	{ 2753 liquid water 2592 steam* }	720	9940	2209
Cyanogen and oxygen	C ₂ N ₂ +O ₄	116	2263	580	8760	2195
Nitrogen sulphide ..	NS	46	694	485	8270	"
Nitroglycerin	C ₃ H ₅ O ₃ (NO ₂) ₃	227	{ 1579 liquid water 1480 steam* }	713	10950	5000 in 75% dynamite.
Nitromannite	C ₆ H ₈ O ₆ (NO ₂) ₆	452	{ 1526 liquid water 1459 steam* }	692	11500	"
Gun-cotton	C ₂₄ H ₂₉ O ₉ O ₁₁ (NO ₂) ₁₁	1143	{ 1074 liquid water 1022 steam* }	859	10000	5000 to 6000
Potassium picrate ..	KC ₆ H ₂ (NO ₂) ₃ O	267	781	549	$\frac{5600}{n-0.14}$	"
Mercury fulminate ..	C ₂ H ₂ N ₂ O ₂	284	{ 463 gaseous mercury† }	314	{ 6200 24700|| }	"
Diazobenzol nitrate ..	C ₆ H ₅ N ₂ (NO ₃)	167	688	818	about 7600	"
Gunpowder	{ 74.7 nitre 10.1 sulphur 14.2 carbon 1.0 water }		720 to 738	278 to 263	$\frac{2193}{n-0.68}$	"

* This volume represents the reduced volume. In those cases where the reaction produces aqueous vapour, the volume of this substance is included in the reduced volume, whereas in fact it is only gaseous at some temperature t higher than 0° ; that is to say, the volume assigned to the aqueous vapour ought to be multiplied by $1 + \frac{t}{273}$, t being the temperature produced at the moment of the explosion. But then the heat disengaged ought to be diminished by the amount absorbed in vaporising the water, a quantity which Berthelot takes, for simplicity, as equal to 10,000 cal. for 18 grms. of water. He neglects, on the other hand, the effect of dissociation, since the value to be assigned this has not yet been determined.

† The mercury is supposed gaseous, as it is considered at a temperature above 360° . The real volume is then $314 \left(1 + \frac{t}{273}\right)$. The heat disengaged has been diminished by the latent heat of vaporisation of mercury.

‡ These pressures represent the limit toward which the observed pressures tend under a density of loading of $\frac{1}{n}$ (1 grm. of matter in n c.m.³) when n tends towards unity. In the case where a non-volatile residue is produced, the volume of this residue ought to be deducted from n , as is done in the cases of potassium picrate and gunpowder.

|| In its own proper volume, that is to say for a density of loading when $\frac{1}{n} = 4.43$.

Am. Chem. Jour., 6, 423, Feb., 1885, of "A Treatise on the Principles of Chemistry," by M. M. Pattison Muir. He says: "Chapter IV. is devoted to the *Applications of physical methods to questions of chemical statics*. Of the physical methods the first considered are the thermal methods. The subject is treated clearly; indeed, it would be difficult to find anywhere a more satisfactory statement in regard to the method and results of thermo-chemistry than we here have included within fifty-odd pages. After showing that the thermal value of even the simplest chemical change is really the sum of various changes, some of which have a positive and others a negative value, and that in most, if not in all cases, it is impossible to assign values to each of the simple changes involved, the conclusion is drawn, that until 'the distinction' implied in the terms atom and molecule 'is practically recognised in thermal chemistry, we cannot expect any great advances to be made in applying the mass of data already accumulated to questions of chemical actions and reactions.'

'Berthelot's work is saturated with the conceptions of the molecular theory; but, by some fatal perverseness, he refuses to apply this theory to chemical phenomena. While recognising the existence of molecules, and building his generalisations on a molecular foundation, he refuses to accept the conception of atom, or rather he hopelessly confuses it with that of equivalent. The molecule is for him a definite and definable portion of matter, the parts of the molecules are only numbers.'

"This criticism may sound harsh, but it appears to be just. At all events we shall be glad to hear what the disciples of Berthelot may have to say in reply. We commend this part of the book to the careful attention of those who have 'blindly pinned their faith' to investigations in the field of thermo-chemistry. While something has been learned, and much more will be learned, in regard to the nature of chemical action by a study of thermal phenomena, it must be acknowledged that the results thus far reached are extremely meagre." In this connection consult the same Journal, 5, 147 and 293, also 6, 202.

Through the courtesy of Manuel Eissler we have received a copy of his "Modern High Explosives," in the form of a large octavo of 495 pages, published by John Wiley and Sons, 1884. The book is arranged in three parts; the first of which describes the processes employed in the manufacture of high explosives, and the methods of analysis and chemical properties of these bodies and their constituents; the second treats of the methods for operating with these explosives; while the third deals with the principles of blasting, and gives the results obtained in many engineering, mining, and military operations. Mr. Eissler designed, erected, and managed the American Forcite Company's works,* and has had considerable experience in the use of high explosives, and hence he has been able to gather together and present in the last two parts of his book a large amount of information and data which will be of value and use to the practical man in determining the amount of an explosive necessary to do a given work and the best way of applying it. The first part, on the other hand, is quite unsatisfactory, as it is so marred by errors in chemical terminology and technical phrases as to be quite bewildering.

One of the most novel and interesting chapters in the book is the one on "Big Blasts," where, among other instances, it is stated that it sometimes happens in the system of hydraulic mining in vogue in California that banks of gravel are met with which are so firmly cemented together as not to yield readily to the action of the water, while other banks are so high that it becomes dangerous to bring the stream sufficiently close for the water to exert its disintegrating force. Under these circumstances recourse is had to what is termed "bank-blasting," in order to loosen the earth so that it will break down under the pressure of the water, and enormous quantities of explosives are used for this purpose. Mr. Eissler gives a detailed description of the method of laying these charges,

and he says that in the diggings at Smartsville, San Juan, More's Flat, Bloomfield, and elsewhere in California, it is an almost daily occurrence to fire blasts where twenty, thirty, and even fifty thousand pounds of explosives are used in a single charge, and that this system of large blasts has even become common in hard rock excavations, such as quarries and railroad cuttings.

We learn that a second volume is in course of preparation, and from the scope of the projected work it promises to be of great value.

A circular from the Judson Powder Company gives the following instances of "big blasts," in which this powder has been used:—June 29th, 1882, 23,000 pounds were fired in a limestone quarry at Glendon, Pa., and it is estimated that it moved 150,000 tons of rock. January 11th, 1883, 29,000 pounds of frozen powder were fired at the same place with good results. At Shell Rock, on the Oregon R. and N. Co. R. R., 10,000 pounds of powder, in one charge, moved 56,000 yards of solid rock. At Jacob's Ladder, on the same road, 21,000 pounds of powder moved 110,000 yards of solid rock.

Through the kindness of Gen. Abbot we are in receipt of Addendum II. of his Report on Submarine Mines,* in which the results of recent experiment on Atlas powder, Judson powder, Rackarock, Forcite, and explosive or blasting gelatin, are given.

Two grades of Atlas† powder, A and B, were used, of which the composition was—

Grade A.—Sodium nitrate	2
Wood fibre	21
Magnesium carbonate	2
Nitro-glycerin	75
	100

Grade B.—Sodium nitrate	34
Wood fibre	14
Magnesium carbonate	2
Nitro-glycerin	50
	100

The firing trial showed Atlas A to be precisely equivalent to dynamite No. 1, when fired under water; while Atlas B, under the same conditions, showed an intensity of action in the horizontal plane equal to 99 per cent of dynamite No. 1, for equal weights.

Several grades of Judson powder‡ were tested. The one most commonly used, and which is sold at the price of common saltpetre blasting powder, is the R. R. P., which has the composition—

Sodium nitrate	64
Sulphur	16
Cannel coal	15
Nitro-glycerin	5
	100

It is manufactured at the New Jersey Works by first grinding the nitre, sulphur, and coal separately, to a fine powder, and then thoroughly incorporating them in a barrel mixer to form a coarse meal powder. This is then heated on a steam pan (150 pounds pressure and 350° F.), and constantly stirred until the sulphur melts and coats the particles of the nitre and coal. The mass is then thrown out and allowed to cool, and it forms conglomerate grains, which are sorted by sieves and coated with nitro-glycerin by stirring. The theory of this manufacture is the same as that claimed by Mr. Mowbray for his mica powder, viz., the coating of a non-absorbent base with nitro-glycerin, by which the quickness of explosion is promoted. The prime difference between the powders lies in the fact that Judson employs an explosive base, while Mowbray's is inert. The advantage sought for here

* *Proc. Nav. Inst.*, ix., 287, 754.

† *Ibid.*, xi., 116.

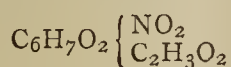
‡ *Ibid.*, xi., 116.

* *Proc. Nav. Inst.*, 11, 98.

is to obtain the maximum potential energy of the explosive base through the initial action of the small charge of nitro-glycerin.* The intensity of action of the R. R. P. of different makes, fired under water, was found to equal 38 to 39 per cent of dynamite No. 1, while some of the other grades rose as high as 78 per cent. The lower grade seemed to be insensitive to the shock of the ball from a Springfield rifle at twenty paces, and when ignited by a match, in charges of $1\frac{1}{2}$ pounds, it burned for about forty-five seconds with a strong yellow flame, but with no such flashing as occurs with ordinary gunpowder.

In addition to the rackarock mentioned in these Notes,† Mr. Divine, the inventor, has patented several other formulæ in which the potassium chlorate is finely powdered and mixed with nitro-benzol and sulphur, or with "dead oil" of tar and sulphur, or with "dead oil" of tar, sulphur, and carbon disulphide in varying proportions. Several of these mixtures were tested, and they gave results varying from 77 to 104 per cent as compared with dynamite. Gen. Abbot seems to be favourably impressed with this explosive, and recommends its trial in blasting and for use in shells.

The forcite gave results which varied, with the grade, between 88 and 133 per cent, and hence it compared favourably with Nobel's explosive gelatin. It was found that the higher grade was the more liable to sympathetic explosions, but that both those tested were much less sensitive than dynamite No. 1 under similar conditions. When the forcite-gelatin was exposed for several hours to a temperature of 100° F., a slight exudation of nitro-glycerin was observed. The manufacturers state that the base for all grades of forcite‡ is mixed with a special kind of "cellulose," whose formula is—



which permits them to operate and manufacture cold. As they state that in manufacturing Nobel's gelatin a temperature of 170° F. is necessary for incorporation, and that this temperature renders the nitro-glycerin very sensitive to concussion and quite dangerous to transport, they claim the cold process as an advantage. A hydrocarbon is used as a solvent for the forcite mixture, and its action renders the product water-proof.

The blasting gelatin used in these experiments came from Nobel's Explosive Co. of Glasgow, Scotland. It was without camphor, but directions for easily camphorating it are given. The composition was 92 per cent nitro-glycerin and 8 per cent nitro-cotton. The test gave the relative intensity as 142, showing this to be the most powerful explosive yet tested at the station. Its sensitiveness to sympathetic explosion was the same as that of the higher grade of forcite.

Gen. Abbot gives a tabular view and also a graphical diagram of relative intensity of the modern high explosives, as shown by the results obtained in his experiments, and he draws the following conclusions:—

- I. The assumption sometimes made that the economic value of a dynamite is simply proportional to the known percentage of nitro-glycerin it contains is shown to be erroneous. A judiciously selected base adds enormously to the energy developed by the nitro-glycerin alone.
- II. There appears to be an advantage in gelatinising the nitro-glycerin before its absorption.
- III. The composition of the base is practically as well as theoretically a very important matter. For example, the lower grades of forcite and rendrock, which are very similar in composition, show nearly equal intensity; and the same is true of dynamite No. 2 and Vulcan No. 2; but both grades of electric powder fall far behind these rivals.

IV. It seems to be a general law that with any particular kind of base there is an economic gain in increasing the percentage of nitro-glycerin up to a certain point, but that beyond that point the advantage ceases.

The instructors in the Department of Ordnance and Gunnery, U.S. Naval Academy, have prepared a work for use in instruction in that department, entitled "Text-book of Ordnance and Gunnery," 1884, in which the most modern advancements in the construction and use of ordnance and ammunition are described by the aid of many excellent plates and cuts, while the latest data are discussed according to the most approved methods. The progress in the art of gunnery is so rapid that the best text-books and treatises soon become imperfect, and it is for the purpose of bringing the instruction into accordance with modern views and methods that this book has been prepared.

(To be continued.)

NOTICES OF BOOKS.

An Introduction to the Study of the Compounds of Carbon, or Organic Chemistry. By IRA REMSEN, Professor of Chemistry in the Johns Hopkins University. London: Macmillan and Co.

THIS manual of what is ordinarily known as organic chemistry has some distinguishing features. It is written without reference to any syllabus or to preparation for any examination. The author has sought to adapt his work to the requirements of all students of chemistry, whether their immediate object may be the cultivation of the abstract science or its applications in the arts or in medicine. He rightly questions how the technical and the medical student can rightly grasp the special manuals prepared for their use unless they have first acquired a sound knowledge, at least in outline, of the fundamental principles of the science. It is unfortunate that, in England at least, so many persons think that the technical student should at once grapple with his intended speciality, overlooking general principles as idle theorising. In the work before us only a comparatively small number of compounds are taken up, for the purpose that they may be more thoroughly discussed than is customary in an elementary treatise. Prof. Remsen seeks not to lay before his readers a great number of details, but to show characteristic facts in their mutual relations. He considers two members of the first series of hydrocarbons, and then their derivatives, as representatives of the corresponding derivatives of other hydrocarbons of the same and of other series. The remaining hydrocarbons are discussed much more briefly, such facts being dealt with prominently as have not been illustrated in the first two members considered. The author remarks that "a very excellent practice is to trace connections between different classes and compounds, and show how to pass from one to another."

We can with a good conscience recommend this book as a safe guide to the rational chemistry of the carbon compounds.

The Art of Soap Making: a Practical Handbook of the Manufacture of Hard and Soft Soaps, Toilet Soaps, &c., including many New Processes, and a Chapter on the Recovery of Glycerin from Waste Lays. By ALEXANDER WATT. Second Edition, carefully revised. London: Crosby Lockwood and Co.

It was only in the course of last year that it became our duty to notice this work on its first appearance, and to express concerning it a mainly favourable opinion. That a second edition should be called for thus early "encourages

* *Proc. Nav. Inst.*, viii., 665.

† *Ibid.*, ix., 755.

‡ *Ibid.*, xi., 99.

the belief that the book supplied a public requirement," as the author observes in his preface.

The arrangement of the work has not been altered, but Mr. Watt has availed himself of the opportunity offered for modifying a few passages to which exception had been taken by the scientific press, or which were capable of being misunderstood.

We have no doubt that this new edition will meet with no less favourable a reception than fell to the lot of the former.

Veterinary Pharmacology and Therapeutics. By J. B. GRESSWELL, M.R.C.V.S. London: H. K. Lewis.

THIS work contains, first, an account of the drugs and chemical compounds used in veterinary practice arranged in alphabetical order, their appearance, properties, applications, and doses. We perceive that Latin prescriptions are now figuring in veterinary literature, mixed, however, with others in plain English—a step evidently not in the right direction. Recently-discovered remedies are duly noticed, and several substances not as yet introduced into veterinary practice, but which have been successfully applied in human diseases, are recommended for trial.

Under "Curare" we find it mentioned that sulphuric acid alone imparts a red colour to solutions containing curarine sulphate, though no such reaction is observed with the salts of strychnine.

As test solutions we find recommended for the detection of albumen in urine a solution of picric acid, and a solution of sodium chloride acidified with hydrochloric acid. As sugar tests are mentioned Fehling's liquid as modified by Martindale, and Dr. Pavy's "cupric pellets."

The remainder of the work is devoted to a "Therapeutic Index of Diseases and Symptoms." It is certainly remarkable what a vast number of diseases are common to man and to the domestic animals.

Proceedings of the Seventh Annual Meeting of the New York State Pharmaceutical Association, held in Saratoga Springs, June, 1885. Also the Constitution, Bye-laws, and Roll of Members. Elmira: Advertiser Association.

THE first matter we have here to notice is the "List of Queries to be answered at the next meeting," some of which can only be answered after much research. Thus the question is raised: "Does a saturated solution of salicylic acid prevent the development of germs of fungi in all alkaloids?" Again: "What is the comparative value of the host of tests proposed or used for albumen in urine?" The problem "examine the commercial argols; determine the nature and the amount of their impurities," seems to us as more fitting to be put at a congress of dyers and calico-printers than one of pharmacists. But the strangest query probably ever propounded is the following:—"Are the vices of pharmacists, as men, as serious as those of men in other professions?" How statistics of vices are to be procured, without which this question is unanswerable, we fail to see.

The proceedings at the meetings relate chiefly to business questions, and have consequently a mere local interest. The Committee on Adulterations has not presented a report. Much time seems to have been devoted to the consideration of restrictions on the sale of poisons, a movement with which, for various reasons, we have little sympathy.

Journal and Proceedings of the Royal Society of New South Wales for 1884. Vol. XVIII. Edited by A. LIVERSIDGE, F.R.S., Professor of Chemistry and Mineralogy in the University of Sydney. Sydney: Thomas Richards. London: Trübner and Co.

AMONG the papers here inserted we notice in particular "Notes on Gold," by Dr. A. Leibius, F.C.S. The author

describes the Mount Morgan Mine, in Queensland, a mountain ridge of ferruginous quartz in which gold is finely disseminated. The ridge is supposed to be the result of a thermal spring which in remote ages held quartz, iron, and gold in solution, and from which the gold has been precipitated in a finely-divided state. The return is 5 ozs. to the ton. The gold assays 99.7 per cent of gold, the rest being copper with a trace of iron. Silver is only present in minute traces—a quite exceptional feature. Another curious fact is that only about half the gold is extracted by the ordinary quartz-crushing and amalgamation process. The tailings are being stored with a view of their further treatment by the chlorination process.

Prof. Liversidge communicates a paper on some "New South Wales Minerals." He mentions native gold found in association with antimonite, crystalline gold, very fine tourmalines, and chrome-iron in a vein 40 feet in thickness.

CORRESPONDENCE.

ADULTERATION OF LARD.

To the Editor of the Chemical News.

SIR,—In your issue of April 2nd Mr. W. Brown remarks upon the prevalence of watered lard, and mentions the presence of a gelatinous adulterant.

According to my experience what is sold as lard is not lard at all, but *pork dripping*. This is shown by the melting-point, *e. g.*—

Pure home rendered lard melts at	112° F.
Chemists' prepared lard	113
Grocers' (I.)	106
„ (II. American)	96
„ (III.)	95
„ (IV.)	103
„ (V.)	102
Bacon fat	90

It is an acknowledged fact that the manufacturer melts down the whole available fat of the pig; but should the product be called lard? Certainly not, any more than beef dripping is entitled to the name of suet. Lard is the fat from the *omentum* or "leaf" of the pig, and from no other part. The melting-point of lard is of the highest importance when it is used for making pastry. The quality of the crust materially depends upon it. In the hands of a good cook pure lard furnishes a puff paste an inch or more in thickness, while lard of 95° melting-point yields a tough hard crust, unbreakable by a spoon. I have purposely had experiments made, under my supervision, with lards of various melting-points, and the rise in the crust was exactly proportional with the rise of the melting-point of the lard employed.

It is a noticeable fact that pure lard always solidifies with a crinkled surface, while shop lard is perfectly smooth.—I am, &c.,

A. PERCY SMITH, F.I.C.

Rugby, October 10, 1885.

Investigations on the Water of the Meuse.—W. Spring and E. Trost.—The proportion of suspended matter in the water is greatest when the river is high; that of dissolved matter follows an inverse rule. Of the rain which falls on the area drained by the Meuse, 62 per cent is removed by evaporation. The height of the river is in general inversely as the intensity of the evaporation. —*Biedermann's Centralblatt*, vol. xiv., Part 3.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 13, Sept. 28, 1885.

Researches on the Nitro-celluloses.—Ch. E. Guignet.—The author is of opinion that gun-cotton prepared at high temperatures and used as an explosive represents almost pure deca-nitro-cellulose. The gun-cotton prepared for collodion with a mixture of sulphuric acid and nitre constantly contains sulphuric acid and potassium in a special organic combination. This product, possibly, does not represent a pure chemical species. The author has not succeeded in preparing Sutton's alcolene, described as being entirely soluble in alcohol. He admits four distinct nitro-celluloses, each of which may be regarded as cellulose in which, respectively, 4, 6, 8, or 10 mols. of water are replaced by the same number of mols. of hydrated nitric acid. The nitro-celluloses are therefore true compound ethers formed from cellulose. In contact with powerful bases it ought to yield nitrates and reproduce cellulose, but the reactions are far more complex, and vary with the conditions of the experiment. In contact with an alcoholic solution of potassa gun-cotton turns brown and is heated to the point of explosion. Gun-cotton is slowly attacked by ammoniacal alcohol, partially dissolving in the course of a few days. The undissolved portion consists of short fibres, slightly curved, and simulating crystals. The aspect of this material is absolutely different from that of the original gun-cotton as seen under the microscope.

A New Spectroscope.—S. G. Govi.—The author describes a direct vision spectroscope, without prisms and without screens. It is merely requisite to employ a very dispersive medium (carbon disulphide, oil of cassia, heavy flint-glass) inclosed between plane, parallel surfaces. This arrangement gives a very fine spectrum merely by the internal dispersion. The coloured rays issue by the second surface of the medium, parallel to the incident rays. There is, therefore, no deviation, and Fraunhofer's rays, or the luminous spectral lines, are seen quite as well as in ordinary spectra.

Separation of Liquefied Atmospheric Air into Two Distinct Liquids.—S. Wroblewski.—The laws of the liquefaction of atmospheric air are not those of the liquefaction of a simple gas. If at first sight air presents itself in such a manner that it is permissible to speak of the critical point of the air, this depends merely on the slight difference which exists between the curves of tension of watery vapour, of oxygen and nitrogen. Whilst the vapour tension of the liquid evaporated by the pump continually diminishes in a progressive manner the temperature passes through a series of maxima and minima. Under low pressures it ultimately arrives at values little higher than those presented by pure oxygen at the same pressure. In these conditions the air contains merely a very slight quantity of nitrogen. Air can further yield two quite distinct liquids, different in appearance and composition, the one superimposed upon the other, and separated by a perfectly visible meniscus. The author arrived at this result as follows: after having liquefied at -142° a quantity of air in the tube of his apparatus, he allows such a quantity of gaseous air to enter the tube that the pressure of the gas is equal to 40 atmos., and its optical density equal to that of the liquid. The meniscus of the liquid is effaced and disappears entirely. He then slowly diminishes the pressure, and at the moment when the gauge shows a pressure of 37.6 atmospheres a new meniscus appears at a point of the tube much higher than that occupied by the meniscus which has disappeared. A few moments afterwards the old meniscus returns to

the point where it disappeared and at this moment two liquids are distinctly recognised and remain separate for some seconds. The lower liquid contains 21.28 vols. per cent of oxygen, and the lower 17.3 to 18.7 per cent.

Genesis of Sulphur Crystals in Square Tables.—M. Brame.—This paper cannot be usefully reproduced without the accompanying figures.

Bulletin de la Société Encouragement pour l'Industrie Nationale. 3rd Series, vol. xii., August, 1885.

The Magnesia Industry.—Th. Schloesing.—The author describes his process for obtaining magnesia in the form of infusible bricks, for the linings of furnaces, &c. His procedure has been already noticed.

Natural Gas and its Industrial Applications.—From *Engineering*.

Soldering and Repairing Platinum Utensils for the Laboratory.—J. W. Pratt—From the CHEMICAL NEWS.

A New Method of Volumetric Analysis, applicable to the Assay of Manganese Peroxide.—Paul Charpentier.—From the *Comptes Rendus*.

Journal de Pharmacie et de Chimie.
Series 5, Vol. xii., No. 6, September 15, 1885.

Composition of the Water of Uriage.—E. Peligot.—A memoir rather of medical than of chemical interest.

New Process for the Rapid Detection and Determination of Small Quantities of Nitric Acid in Air, Water, Soil, &c.—A. Grandval and H. Lajoux.—This paper will be inserted in full.

On Pathological Urines.—A. Villiers.—Already noticed.

Solubility of Mercuric Oxide in Fatty Bodies.—C. Méhu.—A purely pharmaceutical paper.

On Panification.—M. Balland.—Already noticed.

Volumetric Determination of Potassa.—M. Dubernard.—This process is applicable to all potassium compounds, carbonates, sulphates, chlorides, nitrates, phosphates, &c. The author prepares a solution of 12 to 15 per cent of sodium chloro-platinate in alcohol diluted with an equal volume of water, and, on the other hand, a silver solution containing 12 to 15 grms. nitrate per litre. To standardise these liquids he measures very exactly 10 c.c. of the platinum liquid, which he pours into a 100 c.c. flask. He adds a pinch of zinc powder, and raises the temperature to a boil for a minute. All the platinum is thus precipitated, and there remain in solution merely sodium and zinc chlorides. The liquid is made up to 100 c.c. with distilled water, filtered, and in half of the filtrate these chlorides are determined with the silver solution. If 40 c.c. are found, on multiplying this number by 4 we have 160 c.c., which represent 20 c.c. of the platinum solution. On the other hand, he weighs exactly 0.50 grm. of a potassium salt chemically pure, nitrate or sulphate, dissolves this salt in a 100 c.c. flask with a few c.c. of distilled water, acidulates with nitric acid, precipitates the potassa with 20 c.c. of the nitric acid, makes up the volume to 100 c.c. with alcohol at 95 per cent, filters off 50 c.c. which is reduced in heat with a pinch of zinc powder in a 100 c.c. flask: $160 - 48 = 112$ c.c. represent 0.50 potassium nitrate or 0.232 potassa. To effect the determination of any potash whatever we follow exactly the course thus described, taking 10 c.c. of a solution of the sample at 5 grms. in 100 c.c. The determination of the chlorides pre-existing in the sample is effected with the same silver solution (which is standardised for this purpose), and the number of c.c. found for this half grm. is deducted from the silver standard found after reduction by zinc.

Revue Universelle des Mines, de la Metallurgie, &c.,
No. 3, May and June, 1885.

Electrolytic Treatment of Copper Ores.—M. E. Marchese.—A portion of the ore, calculated according to its composition, is melted to a regulus (copper, iron, sulphur) in order to obtain the anodes necessary for the operation. The other portion is simply roasted in order to produce a solution containing the quantity of copper sulphate necessary to utilise the attack of the iron sulphide of the anodes in the electrolysis of the same copper sulphate. The progress of the work is as follows: 1. The portion of the ore destined for the formation of the anodes is melted to a regulus in the ordinary manner. This regulus is cast in plates of no great thickness and of a size suitable to the voltameters adopted, introducing at the same time a slip of copper to connect them to the principal conductors. The plates thus prepared are placed as anodes in electrolytic troughs (voltameters). The cathodes are formed of slender plates of copper. The ores are roasted in order to obtain the sulphates necessary for electrolysis. The roasted ores are submitted to a systematic lixiviation with the addition of sulphuric acid to dissolve the copper in the state of oxide. The solution containing the sulphates is run into the electrolytic troughs. The copper sulphate is decomposed by the electric current; the copper is thrown down upon the cathodes and at the same time the sulphides forming the anodes are attacked. There are formed then iron sulphates which prevent the deposition of iron from the ferrous sulphate and the disengagement of hydrogen. The copper is precipitated from the solution, being deposited chemically pure and compact upon the cathodes. To preserve a suitable degree of saturation and composition in the solution it is passed from the collecting tube of the electrolytic troughs to the lixiviation tanks, a regular and continuous circulation being kept up. The circulating solution has a power of oxidation capable of dissolving and directly exhausting certain sulphur ores without any previous roasting. The greater portion of the electromotive force necessary for the decomposition of the copper sulphate is yielded by the oxidation of the iron contained in the anodes; the electromotive force necessary for each electrolytic trough, for the work of dissociation and the maintenance of a current economically sufficient is less than 1 volt. The exhausted anodes are utilised for the production of sulphur or sulphuric acid. Only one fusion is applied, and that to a part of the ore only.

NOTES AND QUERIES.

** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

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NOTICE IS HEREBY GIVEN that the said Frank Wirth has applied for leave to amend the Specification numbered as above.

A copy of the Specification as proposed to be amended can be inspected at the Patent Office, and full particulars of the proposed amendment were set forth in the Official Journal of the Patent Office published on the 6th October, 1885.

Any person intending to oppose the said application must leave particulars of his objection thereto at the Patent Office, 25, Southampton Buildings, London, W.C., within one calendar month from the date hereof.

Dated this 6th day of October, 1885.

(Signed) J. CLARK HALL,
Deputy Comptroller General.

A. M. and WM. CLARK,
Patent Agents,
53, Chancery Lane, W.C.

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THE CHEMICAL NEWS.

VOL. LII. No. 1352.

PLEA FOR THE EMPIRIC NAMING OF ORGANIC COMPOUNDS.*

By WILLIAM ODLING, M.A., F.R.S.

"Stare super vias antiquas."

(1.) A STUDY of the properties of organic compounds serving for their identification and classification, and more especially a study of the properties of isomeric organic compounds, leads to the assignment to the several bodies of particular structural formulæ. For example, a study of the properties of the body known as cyanic ether or ethyl-carbimide, of which the synoptic or empiric formula is C_3H_5NO , leads to an assignment to the body of the structural formula, $(H_5C_2)N.CO$ or $(H_3C.H_2C)N.CO$.

(2.) Structural formulæ of this kind are made use of indeed by different chemists in a somewhat different sense. For example, the use by different chemists of the above structural formula for ethyl-carbimide, $(H_5C_2)N.CO$ or $(H_3C.H_2C)N.CO$, would be intended by one set of users mainly as an assertion of the resolubility of the compound by hydrolysis into ethylamine and carbonic acid; while it would be intended by another and more numerous set of users mainly as an assertion of there being an actual combination of the one constituent atom of nitrogen of the compound with two particular constituent atoms of its carbon. And as in this particular instance, so in general, the structural formulæ adopted by common consent for the same bodies are regarded by one set of chemists merely as condensed expressions of the formative and transformative reactions of the bodies formulated, and by another set of chemists as expressions of their ascertained and determinate structural constitution.

(3.) This difference of view, however, as to the meaning of structural formulæ in general, has only a secondary bearing on the question of nomenclature. On either view it is alike possible, and more or less customary among chemists, to accord to different organic compounds names which are in effect verbal translations of the structural formulæ deduced for them. Thus no difference of view among chemists as to the shade of meaning to be attached, for example, to the formulæ $CH_2(CH_3)_2$ and $C_2H_2(CH_3)_2O_2$, interferes with their common use of the corresponding structural names, dimethyl-methane and dimethyl-acetic acid for the bodies otherwise known as propane C_3H_8 , and isobutyric acid $\sigma C_4H_8O_2$, respectively. There seems moreover, at the present time, and especially among younger chemists, to be a growing preference for structural or so-called constitutional names of this kind; nor can it be denied that the general application of these names to compounds of which the structural formulæ are held to be established is attended with certain specific advantages.

(4.) In the first place, names of this kind are applicable to all such organic compounds whatsoever, simple or complex, known, or yet to become known; for no sooner does the study of a new compound lead up to its structural formula, than its formula at once determines for it a name. Thus on the discovery of an iso-cenanthic acid $\sigma C_7H_{14}O_2$, referrible to the structural formula—



it could at once have assigned to it the name of methyl-ethyl-butyric acid. Secondly, names of this kind, besides constituting the familiar names of many well-known bodies as methyl-aniline or methy-phenyl-amine, carb-

anil-amide or phenyl-urea, &c., &c., are practically the only kind of names applicable to certain more or less complex varieties of organic compounds; or, in other words, they constitute the only kind of names applicable to all organic compounds whatsoever. Thus, except by the use of distinguishing structural names, it is scarcely conceivable how the six conceivable varieties of iso-cenanthic acid, for example, could be satisfactorily named at all. Lastly, the occasional use of names of this kind cannot be dispensed with, even in the case of comparatively simple organic compounds possessed of familiar empiric names. It is hardly possible, for example, to avoid speaking of such a well-known body as propionic acid under the name of methyl-acetic acid, when comparing its constitution and formative and transformative reactions with those of isobutyric or dimethyl-acetic acid, and of that variety of valeric acid constituting trimethyl-acetic acid:—

$H_4C_2O_2$	or	$H_4C_2O_2$	Acetic.
$(H_3C)H_3C_2O_2$	„	$H_6C_3O_2$	Propionic.
$(H_3C)_2H_2C_2O_2$	„	$\sigma H_8C_4O_2$	Isobutyric.
$(H_3C)_3HC_2O_2$	„	$\nu H_{10}C_5O_2$	Neovaleric.

(5.) Admitting, however, the general proposition that these so-called constitutional names have their uses and cannot be wholly dispensed with, and recognising further the specific facts of their applicability in all cases, their exclusive applicability in certain cases, and their advantageous applicability in yet other cases also, it is nevertheless contended that they do not constitute names of the kind most appropriate for general use, more especially as applied to compounds which are by common consent regarded as fundamental members of the several paraffin, olefine, and benzene groups into which the great bulk of organic compounds are commonly distributed. It is contended further that names of this kind constitute eminently undesirable forms of designation for familiar organic compounds; that a general resort to them should be avoided rather than encouraged; and that their use should be restricted as far as practicable to derivative and out of the way compounds, and be not extended to fundamental compounds such as the simpler hydrocarbons, alcohols, and acids, save when under consideration from a special point of view.

(6.) One of the many objections to the habitual structural designation of these fundamental bodies arises not merely from the inordinate length and complexity of the structural names applicable to many of them, and to their familiar derivatives, but to the failure in ready indicativeness of such similarly built up and lengthy structural names, as ethyl-dimethyl-methane, propyl-dimethyl-carbinol, and methyl-acetylen-carboxylic acid, for instance. Admitting that organic compounds, from their number and variety, can only be identified by names which do in some measure describe and characterise them, it still remains beyond question that the primary function of a name is to designate, not to give an account of; and with a view to the prompt mental association of object with name, it is clearly undesirable, save for some weighty and well-established advantage, that chemists should be under any sort of obligation to use habitually such names for example, as di-oxi- or di-hydroxi-succinic acid, brom-hydroxi-propionic acid, ethyl-dimethyl-methane, and β -dimethyl-ethylene, instead of the shorter, more indicative, and more familiar names of tartaric acid, bromolactic acid, isopentane, and isobutylene, respectively.

(7.) A more important objection to this class of names for general use lies in the fact of their being based on theoretical grounds, which are, at the best, far less assured than are the grounds that suffice for the designation of the same bodies by empiric names having reference to their origin, function, and relationships, &c. Thus, to warrant the designation of a particular body as dimethyl-methenyl-propylic hydrate, for instance, a host of more or less recondite theoretical considerations have to be relied on. But to warrant the designation of the same

* Read at the Aberdeen Meeting of the British Association, Sept. 11, 1885.

body as an isohexylic or isocaprylic alcohol the only theoretical considerations relied on are of the most elementary and well-established character. Nothing indeed of theory is required beyond the deduction of the molecular formula of the body from its ascertained composition and vapour-density. Anything beyond this is strictly observational, as, for example, the observation of the behaviour of the body with acids and acid-chlorides to yield saline ethers, or so-called esters; and the observation of its behaviour with oxygenants to yield successively an aldehyd and acid, this last being different from the acid furnished by the hydration of primary, and identical with that furnished by the hydration of a secondary, pentyl-cyanide. The properties of the body warranting its designation as an isohexylic alcohol are admittedly dependent, according to our present lights, on the particular constitution of the body, as expressed in its structural name dimethyl-methenyl-propylic hydrate, corresponding to the formula $(\text{CH}_3)_2\text{CH}.\text{C}_3\text{H}_6(\text{OH})$, that of ordinary amylic alcohol being $(\text{CH}_3)_2\text{CH}.\text{C}_2\text{H}_4(\text{OH})$. But if only with a view to permanency in name, it is far better that the body should be designated directly from its observed properties, rather than from its constitution as inferred from its properties; of which inferred constitution its properties are held to be the consequence. Although we may indeed feel ourselves quite assured of the grounds on which we nowadays designate the body as dimethyl-methenyl-propylic hydrate, yet all experience available for our guidance shows that views about structural constitution are eminently liable to suffer change; and it is anyhow beyond question that the probability of a change of view which should render the name isohexylic alcohol inapplicable to the body is infinitely less than the probability of a change of view which should render such a name as dimethyl-methenyl-propylic hydrate inapplicable. It is not meant that our present theoretical conceptions, the outcome of great thought and labour, ought to be held less firmly than they are; but only that having a choice between names dependent on, and other names independent of, these conceptions, the latter class of names, in respect to their probable permanency, are entitled to a weighty preference.

(8.) But of the several objections to which the practice of employing structural names is liable, one of the most serious still remains for consideration. And this objection is that, save as applied to a few bodies only of very simple constitution, all structural names that are not too unwieldy to serve the purpose of names at all, express necessarily a one-sided, and so far an untruthful, view of the constitution of the bodies named, to the neglect and concealment of other modes of view of not less warrant and importance. Taking even so simple an instance as that of the hydrocarbon butane, in order to express its accepted constitution without bias in one direction more than in another, it would require to be called by some such name as methyl-methylen-methylen-methane, a concatenation too preposterous ever to be had recourse to, and yet a trifle to the concatenations required for the full expression of more complex molecules. Short of this butane may, however, be named and formulated as follows, the formulæ numbered 2' and 2 being practically almost identical:—

1. $\text{C}_3\text{H}_7.\text{CH}_3$ Propyl-methane or methyl-propane.
- 2'. $\text{C}_2\text{H}_5.\text{C}_2\text{H}_5$ Ethyl-ethane or di-ethyl.
2. $\text{C}_2\text{H}_5.\text{CH}_2.\text{CH}_3$ Ethyl-methyl-methane.
3. $\text{C}_2\text{H}_4(\text{CH}_3)_2$ Dimethyl-ethane.

Each of the above four structural names for butane is suited for occasional use to bring into prominence some particular set of relationships of the body; but each of them is unsuited for general use by reason of its setting forth too prominently one particular set of relationships to the concealment of various other sets on the whole of yet greater importance. The Publication Committee of the Chemical Society favour the designation of the normal paraffins by binary names such as the first of those given above for butane, and discountenance their designation by

names such as those which follow; but it is doubtful whether the thus favoured structural names for the paraffins, and the allied names suggested for the olefines, have any special advantages or claims to general acceptance, that they should be adopted to the exclusion of other names expressing no less important, though it must be admitted equally one-sided and so far distorted, conceptions of the nature of the bodies. Taking the case of butane, the binary name propyl methane suggests the existence in butane of the radical propyl as a separate entity,—a conception wholly without foundation. On the other hand, it serves to connote the important analogies subsisting between bodies such as those formulated and named below:—

$\text{C}_3\text{H}_7.\text{NH}_2$	Propyl-amine	
$\text{C}_3\text{H}_7.\text{CH}_3$	Propyl methane	<i>Butane.</i>
$\text{C}_3\text{H}_7.\text{CH}_2(\text{OH})$	Propyl-carbinol	<i>Butylic alcohol.</i>
$\text{C}_3\text{H}_7.\text{CN}$	Propyl-cyanide	<i>Butyro-nitrile.</i>
$\text{C}_3\text{H}_7.\text{CO}_2\text{H}$	Propyl-formic acid	<i>Butyric acid.</i>
$\text{C}_3\text{H}_7.\text{SO}_3\text{H}$	Propyl-sulphonic acid (?)	

But who will venture to say that the relationships thus manifested are more important than those indicated in the following series of names and formulæ, in which butane no longer appears as propyl-methane, but now figures under the ternary appellation of ethyl-methyl-methane?

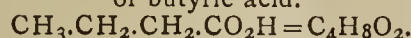
$\text{C}_2\text{H}_5.\text{CH}_2.\text{CH}_3$	Ethyl-methyl-methane	<i>Butane.</i>
$\text{C}_2\text{H}_5.\text{CH}:\text{CH}_2$	Ethyl-ethylene	<i>Butylene.</i>
$(\text{CH}_3).\text{CH}:\text{CH}(\text{CH}_3)$	α -Dimethyl-ethylene	<i>Parabutylene.</i>
$(\text{CH}_3)_2.\text{CH}.\text{CH}_3$	Trimethyl methane	<i>Isobutane.</i>
$(\text{CH}_3)_2.\text{C}:\text{CH}_2$	β -Dimethyl-ethylene	<i>Isobutylene.</i>
$\text{C}_2\text{H}_5.\text{CO}.\text{CH}_3$	Ethyl-methyl-ketone	[<i>cohol.</i>
$\text{C}_2\text{H}_5.\text{CH}(\text{OH}).\text{CH}_3$	Ethyl-methyl-carbinol	20-ary <i>Butyl al.</i>
$(\text{CH}_3)_2.\text{C}(\text{OH}).\text{CH}_3$	Trimethyl-carbinol	30-ary <i>Isobutyl alcohol.</i>
$\text{C}_2\text{H}_5.\text{CH}_2.\text{CO}_2\text{H}$	Ethyl-acetic acid	<i>Butyric acid.</i>
$(\text{CH}_3)_2.\text{CH}.\text{CO}_2\text{H}$	Dimethyl-acetic acid	<i>Isobutyric acid.</i>
$\text{CH}_3.\text{CH}.\text{(CO}_2\text{H)}_2$	Ethidene-diformic acid	<i>Isosuccinic acid.</i>

It is obvious at a glance that while the pre-considered relationships of butane to butyro-nitrile, butyric acid, and butylic alcohol would be expressed somewhat less simply by the conception of butane as ethyl-methyl-methane than by its conception as propyl-methane, the yet more important relationships of butane to butylene, to isobutane, and isobutylene, and to the secondary and tertiary butylic alcohols, concealed altogether by the conception of butane as propyl-methane, are made clearly manifest by the conception of it as ethyl-methyl-methane. Each conception has indeed its own advantages, and suffices for its appropriate occasional uses. But while neither conception is complete or wholly true, the ternary conception is more complete and of greater general applicability than the other. The conception, indeed, of the normal paraffins and of the isoparaffins, as constituted respectively of the grouping CH_2 plus two methyl-like radicals, and of the grouping CH plus three methyl-like radicals, clears the ground covered by at least three-fourths of the existing chemistry of adipic as distinguished from that of aromatic compounds. Isoparaffins, it is observable, may be built up either from primary iodo-derivatives of pre-existing isoparaffins, or from secondary iodo-derivatives of normal paraffins, as shown below; except indeed in the case of isobutane, which, being the simplest term in the series of isoparaffins, can be built up only from the secondary iodo-derivative of the normal paraffin or secondary propyl iodide $\text{CHI}(\text{CH}_3)_2$, often miscalled iodide of isopropyl, notwithstanding its analogy to the secondary iodides of butyl and pentyl, $\text{CHI}(\text{CH}_3)\text{C}_2\text{H}_5$ and $\text{CHI}(\text{CH}_3)\text{C}_3\text{H}_7$, deriving from the hydrocarbons butane and pentane respectively, and its want of analogy to the iodides of isobutyl and isopentyl or amyl, $\text{CH}(\text{CH}_3)_2\text{CH}_2\text{I}$ and $\text{CH}(\text{CH}_3)_2\text{C}_2\text{H}_4\text{I}$, deriving from the hydrocarbons isobutane and isopentane respectively:—

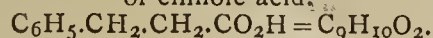
Iodo-isobutane $\text{ICH}_2\text{.CH(CH}_3)_2 + \text{CH}_3\text{I} - \text{I}_2$ or
20-ary Iodobutane $\text{CH}_3\text{.CH}_2\text{.CHI.CH}_3 + \text{CH}_3\text{I} - \text{I}_2 =$
Isopentane $\text{CH}_3\text{.CH}_2\text{.CH(CH}_3)_2$ or
 $\text{CH(CH}_3)_2\text{C}_2\text{H}_5$.

(9.) But the sometimes advantageous constitutional designation of butane is not limited to its expression by the above two structural names alone. Thus when considering its relationship to succinic, malic, and tartaric compounds, it is preferably considered as dimethyl-ethane, corresponding to the formula $\text{C}_2\text{H}_4(\text{CH}_3)_2$; and indeed, according to the accepted view of the constitution of butane, it is just as much dimethyl-ethane as it is either propyl methane or ethyl-methyl-methane, by reason evidently of its having a general constitution inclusive of all three arbitrary distributions of its component matter. Arbitrarily distributive structural names, if used according to a single system, have the baneful result of exhibiting all bodies from a single one-sided point of view, necessarily an unfavourable point of view for many of them; while if used in some cases according to one system, and in other cases according to another system, have the no less baneful effect of dissociating from one another many bodies having an unmistakable real relationship. Thus a well-known aromatic acid, commonly designated as phenyl-propionic acid, would seem to have no association with butyric acid represented constitutionally as propyl-formic acid. The one body appears as a derived formic acid, the other as a derived propionic acid. But they are in truth, both of them, derived formic acids, derived acetic acids, and derived propionic acids, just as we please to regard them, and have both of them a claim to be named accordingly, as indicated below:—

Methyl-propionic, or ethyl-acetic, or propyl-formic,
or butyric acid.



Phenyl-propionic, or benzyl-acetic, or styryl-formic,
or cinnoic acid.



Similarly, ethyl-formic, or propionic acid, is just as truly methyl-acetic acid; and phenyl-acetic, or α -toluic, or storenic acid is just as truly benzyl-formic acid. Again, while propylic alcohol $\text{CH}_3\text{.CH}_2\text{.CH}_2\text{OH}$ is commonly called ethyl-carbinol and formulated as $\text{C}_2\text{H}_5\text{.CH}_2\text{OH}$, the analogous styrylic alcohol $\text{C}_6\text{H}_5\text{.CH}_2\text{.CH}_2\text{OH}$, instead of being named and formulated as benzyl-carbinol, $\text{C}_7\text{H}_7\text{.CH}_2\text{OH}$, is usually spoken of as phenyl-ethol, $\text{C}_6\text{H}_5\text{.C}_2\text{H}_4\text{OH}$, it being, however, just as much entitled to the one name as it is to the other. It comes, indeed, simply to this, that structural names are unfitted for general use as names, by reason of every compound, according to its complexity, demanding the assignment to it of an indefinite number of such names.

(10.) Of course the same sort of objection that applies to the general use of arbitrarily distributive structural names, applies also to the use, without any special purpose to be served, of arbitrarily distributive structural formulæ. But it would seem to be thought nowadays that any knowledge of structure was wholly valueless if it had not a right to be displayed on all occasions, alike in season and out of season. Accordingly, it has become no longer permissible under any circumstances to write the formulæ of alcohol and benzoic acid, for instance, as $\text{C}_2\text{H}_6\text{O}$ and $\text{C}_7\text{H}_6\text{O}_2$ respectively. Not to employ a distributive formula even where the employment of such a formula is entirely uncalled for, would be to proclaim oneself behind the age. Thus to make a comparison of butyric acid with butyramide, one is bound to write the formula of the acid as $\text{C}_3\text{H}_7\text{.CO(OH)}$, if not indeed as $\text{CH}_3\text{.C}_2\text{H}_4\text{.CO(OH)}$; despite the fact that the synoptic formulæ for the bodies under comparison, $\text{C}_4\text{H}_7(\text{NH}_2)\text{O}$, and $\text{C}_4\text{H}_7(\text{OH})\text{O}$, deriving from that of the aldehyd $\text{C}_4\text{H}_8\text{O}$, would answer every purpose, and despite the fact that butyric acid is in the abstract no more a propyl-formic or methyl-ethylen-

formic compound than it is an ethyl-acetic or methyl-propionic compound.

(11.) But, while admitting the force of the several objections raised in the preceding paragraphs, it may yet be urged that among compounds referrible to paraffins constituted of $6+n$ atoms of carbon, the number of isomers, actual and prospective, is so great that the system of using structural names, with all their acknowledged drawbacks, can alone be resorted to for the adequate designation of the compounds so referrible; and that any system of naming by distinctive roots or prefixes applied to such compounds would lead to results at least as cumbrous and confusing as those attendant on the attribution to them of structural names. But this counter-objection, though undeniable as a general proposition, admits of many qualifications when applied to the condition of things actually prevailing. Thus the circumstance of there being a possible host of alcohols or quasi-alcohols referrible to the empiric formula $\text{C}_{16}\text{H}_{34}\text{O}$, does not require us to cease calling the spermaceti-compound by the name of cetylic alcohol, or necessitate our speaking of it instead as tetradecetyl-methylen-methylic hydrate, or even as penta-decetyl-carbinol. Nor, again, does the circumstance that there are four possible isocaproic acids derivable in pairs from each of the two isohexanes, preclude our speaking of the ordinary or propion-dimethylic acid by the simple name of isocaproic acid $\sigma\text{C}_6\text{H}_{12}\text{O}_2$, or of the ordinary or propyl-dimethylic hydrocarbon under the simple name of isohexane $\sigma\text{C}_6\text{H}_{14}$. No ambiguity is involved by the non-use in either case of other than a common prefix, it being taken for granted, unless otherwise indicated, that we mean the ordinary compounds, just as it is taken for granted when we talk of alcohol that we mean ordinary alcohol. If we had meant to speak of one of the other three isocaproic acids we should have specified it in some way, most probably by means of a structural name, as di-ethyl-acetic acid for instance. In a similar manner, the circumstance of there being four possible leucic acids, in addition to paraleucic acid, does not preclude us from speaking of the ordinary or butyl-glycollic compound under the unqualified name of leucic acid. It is understood, as a matter of course, that if we had meant one of the other possible leucic acids we should have qualified the name in some way or other.

(To be continued).

ON THE SOURCE OF THE HYDROGEN OCCLUDED BY ZINC DUST.*

By GREVILLE WILLIAMS, F.R.S.

IN my paper "On the Synthesis of Trimethylamine and Pyrrol from Coal Gas, and on the Occlusion of Hydrogen by Zinc Dust,"† I showed that, under certain conditions, zinc dust behaved towards hydrogen like palladium; and I inferred, from the phenomena observed, that the zinc dust occluded hydrogen at ordinary temperatures, and gave it off in an active condition when heated. In my second paper, "Note on the Occlusion of Hydrogen by Zinc Dust and the Meteoric Iron of Lenarto,"‡ I gave the results of determinations of the amount occluded in the dust by direct heating, and also by combustion with cupric oxide. I likewise made the suggestion that the hydrogen, in the cases both of the dust and the meteorite, had probably been originally derived from water, and not necessarily in the latter case, from the meteorite having at one time been exposed to an atmosphere of hydrogen at a high pressure. The present paper is to be regarded

* From the *Journal of Gas Lighting*. Communicated by the Author.

† See *Journal of Gas Lighting*, vol. xlv., p. 15.

‡ *Ibid.*, vol. xlv., p. 485.

Having shown that the wetted dust after drying gives off nearly double as much hydrogen as was evolved from it in the condition in which it was received, it became important to know how the hydrogen had been occluded by the dust which had not been wetted. It has long been known that shippers are unwilling to carry large quantities of zinc dust in their vessels, owing to the danger of its getting wetted, in which case it becomes heated to an extent which may become dangerous. It being, therefore, extremely improbable that the specimens with which I worked had ever been wetted, or even rendered damp, purposely, it struck me that it had probably absorbed moisture from the atmosphere. This would perfectly account for the presence of hydrogen in the commercial product, and, owing to its being kept closely packed, for the amount being small as compared with that contained in the dust which had been thoroughly wetted. To determine this question, I placed 6.4790 grms. in a watch-glass over a vessel containing water, the whole being then covered by a bell-glass. The apparatus was kept in a room having a nearly constant temperature of about 72° F. It was weighed almost every day from the commencement of the experiment (August 6) until the 17th of September, by which time it had ceased to increase. It was found

that for the first fourteen days it gained about 3 centimetres a day; the next fourteen days the increase fell to about $1\frac{1}{2}$ centigrammes a day; and after this it gradually diminished, and at last entirely ceased. It was then dried in the water-oven until the weight became constant. The substance which had caked together was then pulverised, and taken for the following experiments:—

Experiment I.—One quarter of the usual amount—viz., 1.6198 grms.—was heated in a similar manner to the previous experiments. The corrected volume of hydrogen was 85.3 c.c., which multiplied by 4 gives no less than 341.2 c.c. of hydrogen from 6.4790 grms. This is about seven times the amount afforded by the original dust, and 3.8 times more than the mean of the results obtained with the dust which had been wetted.

Experiment II.—In this experiment, in which the full heat of a strong Bunsen flame was kept until the volume of hydrogen ceased perceptibly to increase, 90.7 c.c. of hydrogen were obtained from 1.6198 grms., or 362.8 c.c. from 6.4790 grms. = 100 grains.

The above results confirm in the strongest manner the views I had entertained as to the source of the hydrogen in zinc dust, and conclusively show that exposure to a moist atmosphere at a moderate temperature is eminently favourable to the condensation of the hydrogen. It is not improbable that, by suitably modifying the conditions, this amount may be exceeded. As zinc dust thus charged with hydrogen can hardly fail to become an important chemical reagent, I shall endeavour to determine the maximum amount that can be occluded, and the ratio to the amount of metallic zinc present.

The Gas Light and Coke Company,
September 22, 1885.

THE COMBUSTION OF CARBO-HYDRATES BY MEANS OF CHROMIC ACID.

By C. F. CROSS and E. J. BEVAN.

IN the course of our researches upon cellulose we have had occasion to seek for a rapid method for the determination of the carbon in compounds of this class. From the various means which lay at our disposal ("Watts's Dictionary," Articles "Analysis") we selected that of combustion with chromic acid in presence of sulphuric acid. We first investigated the reaction in regard to the weight of gas evolved, using for this purpose a modification of the apparatus of Fresenius and Will. Cellulose dissolved in sulphuric acid was placed in the one flask, a pasty mixture of chromic and sulphuric acids in the other. The loss in weight was about 1.5 times that of the cellulose taken, whereas, supposing the carbon entirely converted into CO_2 , the proportional loss should have amounted to 1.6.

The process was then carried out in an apparatus similar to that which is employed in the estimation of carbon in iron by the chromic acid method. The gain in weight of the potash absorption tubes was found to be very considerably less than on the above supposition, and, moreover, to vary with the same substance to the extent of 4 to 5 per cent: thus in the combustion of sugar we obtained 25 to 30 per cent C as CO_2 , i.e., from 60 to 70 per cent of the total.

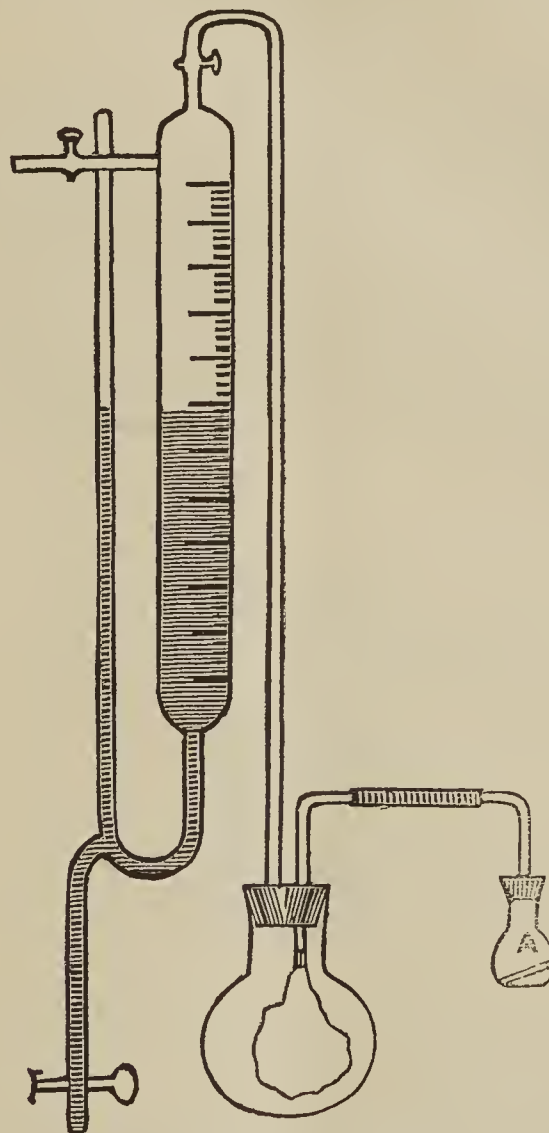
We then proceeded to examine the gases evolved during the combustion: by expelling the air from the apparatus by CO_2 and collecting over strong potash solution, we obtained a considerable volume of a gas which proved to be carbonic oxide.

The next step, was to devise a method of volumetric estimation, since, provided no compounds were formed containing more than 1 atom C in the molecule, the volume of gas evolved could be taken, independently of its composition, for the purpose of calculating into weight, and so the error due to the incomplete combustion

eliminated. For this purpose we constructed a form of Schiebler's apparatus, slightly modified from that described in "Sutton's Volumetric Analysis" (4th edition), page 81.

The annexed sketch sufficiently explains the apparatus and process. The combustion takes place in the flask, A, into which the chromic acid is introduced in a small tube, the substance being previously mixed with or dissolved in the sulphuric acid. After the levels have been adjusted, the chromic acid is mixed with the substance by inclining and shaking the flask.

The greater proportion of the gases is evolved in a few minutes, and the combustion is completed by gently heating the flask.



The following are the results of combustions of Swedish filter-paper:—

Grms.	c.c. CO_2 and CO.	Temp.	Per cent Carbon.
0.1065	91.50	Temp. 15°C .	43.65
0.1365	118.25	Temp. 16°C .	43.80

We have also made a number of determinations of carbon in different cellulosic substances of known composition, which point to the trustworthiness of the method.

Mr. Warrington, in his paper on Schiebler's apparatus, treating of its application to the analysis of carbonates (CHEMICAL NEWS, vol. xxxi., p. 253) has pronounced it, in spite of the errors and the necessity for their empirical elimination, of very considerable utility; and we venture to predict a similar verdict in regard to the application to which we have put it.

It is our intention to investigate this subject with the view of bringing the results of Chapman and Thorp (Chem. Soc. Jour. [2], 4, 417), and Chapman and Smith

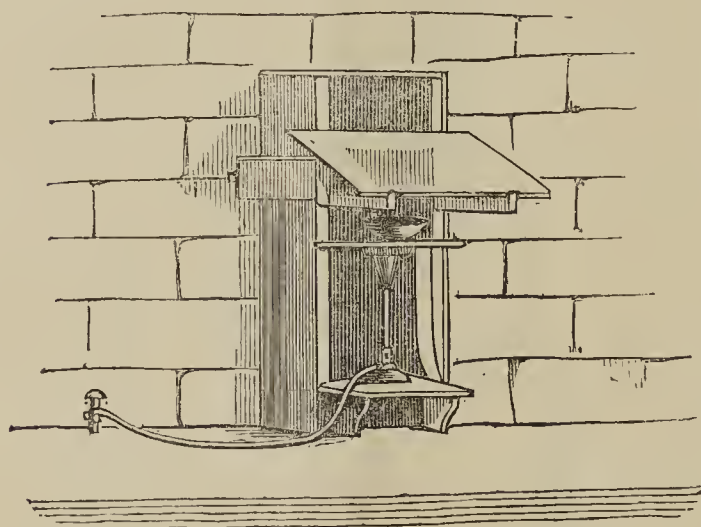
(*Ibid.*, 5, 173) on the regulated combustion of carbon compounds by means of chromic acid, and of Ladenburg (*Annalen*, 135, 1) with silver iodate and sulphuric acid employed for the same purpose, to bear upon the problems of the constitution of cellulose and its derivatives; and in regard to the apparatus, to quantify the errors, and by suitable variation bring them as far as possible under control.

We also hope to make the method applicable to the determination of carbon in other carbon compounds.

ON AN IMPROVED METHOD OF VENTILATING LABORATORIES.

By CHARLES M. STUART, M.A.

In all laboratories the rapid removal of noxious vapour is an important matter, and in many it is very inefficiently performed. Up to the present time the object has generally been attained by means of draught cupboards with sliding windows, which are open to many objections; the most important of which is that the vapour is mingled with a large volume of air before it is carried off, and is therefore apt to leak at any crevices which may exist, or to pour out into the room if the sash be raised for the purpose of manipulation. These cupboards are, in addition, frequently dark, and require the students to be continually moving to and from their benches in order to use them.



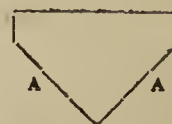
The essentials of good ventilation are that a noxious vapour may be carried away at once, and that the vessel emitting it shall be capable of manipulation without the vapour escaping into the laboratory. In some laboratories recently constructed the improvement has been made of giving each student a draught on his own bench. Such an arrangement exists at Nottingham University College, and is described by Professor Clowes in the new edition of his "Practical Chemistry," a funnel-shaped copper hood, connected with a system of draught-pipes, being placed over the vessel emitting vapour. I am informed, however, by Prof. Clowes that he regards this arrangement as unsatisfactory, because acid fumes attack the copper, and drops of liquid containing copper fall into the vessel in question; the putting up and removing the hood for every operation also involves trouble.

In the *Berlin Berichte*, 18, 1436, an arrangement is described, in which a small slit is made in the chimney itself, over which a glass plate projects, and the liquid to be evaporated is placed under the glass plate. I thought that if this arrangement could be modified so as to be placed on every student's bench the desired end would be obtained, and I have found the following arrangement

work so extremely well that I have thought it worth describing here.

The draught is caused by a square chimney, 1 ft. in the side heated by a ring burner: from the bottom of this a pipe is led under the floor of the laboratory, where it divides and sub-divides into as many branches as are required. Each branch ends in a 4-in. pipe, which is brought up at the back of the student's bench. Over the opening of the pipe is placed a wooden box, 18 ins. to 2 ft. in height, and of the same internal diameter as the pipe, closed on all sides and on the top. In the front of this, at a convenient height from the table, a slit is cut, which can be closed by a wooden slide, capable of being readily pulled out by means of a knob. On each side of the slit is a piece of wood of the shape of a right-angled triangle, supporting a sheet of glass over the slit at an angle of 30° with the horizontal. The dish containing the acid to be evaporated or boiled is placed under the glass and the slit opened; the vapour is carried at once into the system of draught-pipes, and the evaporation proceeds faster because it is conducted in a current of air.

The dimensions I have found useful for ordinary analytical work are as follows:—The slit is 2 ins. wide, and its lower edge is 1 foot above the table; the sheet of glass is 6 × 8 ins. This is a convenient height for boiling test-tubes or small flasks containing acid over a burner; but as most frequently noxious vapours are produced by evaporating acid in a dish, a shelf is arranged on a hinge two or three inches above the table, so that when not in use it can be folded flat against the front of the draught-box; a tripod stand placed on this shelf brings a dish close under the slit. Of course in laboratories where more varied work is done it would be advisable to have one or two slits of different heights and sizes to suit larger apparatus. The figure shows the whole arrangement. Most of the boxes are square in section, but in some cases, where students working side by side had to be provided for, the boxes were made thus in section, and the slits placed in the faces A A.



This arrangement possesses the great advantages that it contains nothing but what can be made by an ordinary carpenter, and that the glass permits one to see the condition of the liquid undergoing evaporation. In my own laboratory there are eight draught-pipes, and as five of them are double, this gives thirteen holes at which liquids may be evaporated. When all of these are open the draught is not so good, but still it is satisfactory; but when, as is nearly always the case, only five or six are open together the draught is excellent, and the glass can be removed and the liquid manipulated without any vapour escaping into the room.

This system has been for some time in use in my laboratory at the High School, Newcastle-under-Lyme, and I can thoroughly recommend it to the notice of any chemist who is interested in the subject.

On Solidification.—E. Reyer.—The solidification of lavas and metals displays complicated phenomena which have given scope to various misinterpretations. Silicates (lavas and glasses) generally solidify in a vitreous form in the dry heat of a furnace. If the congealed mass remains for a long time at a temperature close upon the melting-point, approaches to crystallisation take place, and are promoted by moisture. If glass is embedded, at a high temperature, in gypsum or other substances which give off water, the mass becomes crystalline. Lava as it bursts forth is permeated with water, or, more properly speaking, with saturated solutions. If large quantities of water are present in lava it evaporates in part, producing tumefaction and dissipation in dust.—*Journal für Praktische Chemie.*

REPORT OF THE COMMITTEE ON INDEXING
CHEMICAL LITERATURE.*

THE Committee on Indexing Chemical Literature respectfully present to the Chemical Section their third annual report.

Five hundred copies of our report for 1884 have been sent to chemists throughout the United States, the distribution having been made through the Smithsonian Institution without expense to the Committee; the report was also published in the *CHEMICAL NEWS* (London), and favourably noticed in the *American Library Journal* (New York). This wide circulation led to many applications for single indexes and for sets, which were filled as far as possible either by the Chairman or by Prof. D. S. Martin, editor of the *Annals of the New York Academy of Sciences*, in which serial most of the indexes were published.

But one offer of assistance in the scheme of co-operative indexing has been received.

Dr. F. E. Engelhardt offers to undertake an Index to the Literature of Common Salt.

Reports of progress have been received from several gentlemen:—Professor Wm. Ripley Nichols, on Carbon Monoxide; Professor L. P. Kennicutt, on Meteorites; Professor C. E. Monroe, on Explosives.

During the year Dr. H. Carrington Bolton has published in the *Annals of the New York Academy of Sciences* a Catalogue of Chemical Periodicals (58 pp., 8vo., New York, 1885). This embraces 182 titles in several languages, and is intended to form an authoritative list of all the completed and existing periodicals devoted to chemistry, with a view to facilitating the researches of those undertaking the compilation of indexes.

Dr. Bolton has also completed the second Index to the Literature of Uranium mentioned in our preceding report. This index has been examined by the Committee, accepted and transmitted to the Smithsonian Institution for publication, in accordance with the agreement entered into by the Secretary, Prof. S. F. Baird. Its early publication may be expected.

The Committee deem it part of their duty to chronicle the publication of chemical indexes and bibliographies which may be issued independently, and which fall under their notice. They therefore call attention to the following:—

List of Tests (Reagents), by Hans Wilder. New York and London. 88 pp. 12mo, 1885.

This is a useful little brochure containing a list of nearly 900 chemical tests known by the names of their authors, arranged alphabetically by authors, and provided with a full index of subjects. It can be obtained of Professor P. W. Bedford, 5, Beekman Street, New York, or of E. and F. Spon, 125, Strand, W.C.

In conclusion, the Committee appeal for support to the chemists in whose hands this report may fall; they call for volunteers to undertake indexes to special topics in chemical literature, and especially to the elementary substances. The indexes and bibliographies now on their list number fifteen; cannot this number be soon doubled? The Committee does not dictate to independent workers a fixed plan, but leaves method and subject to the authors: the Committee does not seek to control the productions further than to insure work of high merit and to guard the interests of the Smithsonian Institution, which has agreed to publish manuscripts endorsed by the Committee. Chemists willing to undertake the compilation of indexes are requested to send their names and addresses, with a memorandum of the subject chosen, to the Chairman of the Committee (care of the Smithsonian Institution), who

will furnish sample copies of indexes already in print and other desired information.

Respectfully submitted,

Committee { H. CARRINGTON BOLTON, *Chairman*,
IRA REMSEN,
F. W. CLARKE,
ALBERT R. LEEDS,
ALEXIS A. JULIEN.

August 19, 1885.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from page 196.)

EXPLANATION OF SIGNS.

+ Following a date signifies current at the date in question.

|| Following a date signifies publication discontinued.

158. REVUE DES INDUSTRIES CHIMIQUES ET AGRICOLES.
7 vols., 8vo. Paris, 1878-'84.

RICHTER, J. B.

See Ueber die neueren Gegenstände in der Chemie.

ROZIER'S JOURNAL.

See Introduction aux observations sur la physique [etc.]

159. RIVISTA DI CHIMICA, MEDICA E FARMACEUTICA, TOSSICOLOGIA, FARMACOLOGIA E TERAPIA. Diretta da P. Albertoni e J. Guareschi. 2 vols., 8vo. Torino, 1883-'84.

United in 1855 with Annali di chimica applicata and continued. See Giornale di farmacia c.

SAFARIK, V.

See Casopis chemiku^o ceských [b.]; also Zprávy spolku chemiku^o ceských.

160. SAMMLUNG AUERLESENER ABHANDLUNGEN ÜBER DIE INTERESSANTESTEN GEGENSTÄNDE DER CHEMIE. Aus dem lateinischen mit einigen Anmerkungen begleitet. Redigirt von Hochheimer. 1 vol., 8vo. Leipzig, 1793.

161. SCHEIKUNDIGE BIBLIOTHEEK, waarin de voornaamste nieuwe ontdekkingen en verbeteringen, welke in der scheikunde in ons vaderland, doch wel meest in andre landen van tijd tot tijd gedaan worden, kortelijk worden voorgetragen. Door een gezelschap van beminnaars dezer wetenschap. 2 vols., 8vo. Delft, 1790-'98.

Continued under the title:

[a] Scheikundige (Nieuwe) bibliotheek. 3 vols., 8vo. Amsterdam, 1799-1802.

162. SCHEIKUNDIGE BIJDRAGEN. — vols. Amsterdam, 1867.

163. SCHEIKUNDIGE ONDERZOEKINGEN, GEDAAN IN HET LABORATORIUM DER UTRECHTSCHER HOOGESCHOOL. Uitgegeven door G. J. Mulder. 6 vols., 4to. Rotterdam, 1845-'52.

Followed by:

[a] Scheikundige verhandeligen en onderzoekingen uitgegeven door G. J. Mulder. 3 vols., 8vo. Rotterdam, 1857-'64.

Followed by:

[b] Scheikundige aantekeningen uitgegeven door G. J. Mulder. 1 vol., 8vo. Utrecht, 1865-'67.

Followed by:

[c] Scheikundige onderzoekingen, gedaan in het physiologisch laboratorium der Utrechtsche Hoogeschool. Nieuwe serie. 3 vols., 8vo. Rotterdam, 1867-'71.

Derde serie. 4 vols., 8vo. 1871-'76 [+?]

* Presented to the Chemical Section of the American Association for the Advancement of Science at the Ann Arbor Meeting, August, 1885.

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

SCHFIKUNDIGE VERHANDELINGEN. Rotterdam.
See Scheikundige onderzoekingen.

SCHERER, ALEX. NIC.

See Allgemeine nordische Annalen der Chemie; also
Allgemeines Journal der Chemie; also Archiv für
die theoretische Chemie; also Nordische Blätter für
Chemie.

(To be continued).

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Prof. CHAS. E. MUNROE, U.S.N.A.

(Continued from p. 199.)

A NEW powder known as the Cocoa powder, and made by Rottweil-Hamburg Powder Co. at their works at Düneberg, near Hamburg, has been exciting some attention abroad. It is formed into hexagonal prisms, with one canal, and is of the colour of cocoa, whence the name. Two pamphlets issued by the firm, dated 1882 and 1883, and entitled "Trials executed with Prismatic Powder," have come to hand, from which we extract the following:—

Powder in prisms of 50 m.m. was tested in a 21 centimetre gun of 30 calibers length against ordinary prismatic powder. The Cocoa powder is designated as C/82, the ordinary prismatic as C/75. The results are given in the following table:—

Powder.		Pressure of gas in atmospheres.				Energy of projectile.		
Description.	Charge. Kg.	Weight of projectile. Kg.	Muzzle velocity. M.S.	Rodman gauge.	Crusher gauge.	Total.	Per Kg. of powder.	Per atmosphere Rodman gauge.
C/82	39	140	481	1935	1975	1648	42.3	0.85
C/75	39	"	490	2680	2825	1713	43.9	0.64
C/82	42	"	499	2130	2150	1776	42.3	0.83
C/75	40	"	497	2830	2905	1761	44	0.62
C/82	45	"	519	2365	2380	1922	42.7	0.81
C/75	40	"	506	3035	2970	1827	45.7	0.60
C/82	48	96.5	606	2320	2255	1810	37.7	0.80
C/75	42	"	607	3035	3015	1814	43.2	0.60

The above figures show:—

1. That the new Düneberg Powder, C/82, produces about 700 atmospheres less pressure than the prismatic powder C/75, while the velocity remains the same.

2. That the powder C/82 produces 33 per cent more energy per atmosphere pressure than C/75.

3. That with the powder C/75, a 21 c.m. shell of 3½ calibers length, weighing 140 kg., attains a velocity of 500 metres, only at a comparatively high pressure of gas, whereas the new powder produces velocity at a proportionately low one.

While a charge of 40 kilos. of the old pattern may be deemed too great, on account of the high pressure of gas it produces, a charge of the powder C/82 may safely be increased to 48 kilos.; the pressure thereby produced, reached according to the Rodman gauge but 2615 atmospheres, according to the crusher gauge but 2570 atmospheres; the muzzle velocity was 537 metres.

Other properties claimed for the new powder are comparatively little smoke and a slow rate of burning when unconfined. It was especially noticed at the trial that C/82 gave less and thinner smoke than C/75, which is of the greatest importance, as great quantities of dense smoke dispersing slowly may stop the firing, as was recently the case during the bombardment of Alexandria.

A grain of C/82 powder when ignited in air did not explode like C/75 and C/68 powder, but burned slowly, showing a red flame. A closed box containing 55 kg.

* From the *Proceedings of the U.S. Naval Institute*.

As it is proposed to continue these notes from time to time, authors, publishers and manufacturers will do the writer a favour by sending him copies of their papers, publications, trade circulars, or expert testimony in infringement cases.

of C/82 powder was ignited. The powder burned out in about 10 seconds without any detonation (?) whatever. It was found that the screwed lid had been loosened, without, however, being thrown off the box, and that, with the exception of a few slight burnings, the lid presented the same appearance as before the experiment. The box also escaped without any damage. This property of burning without explosion is of value in the use of powder. Another feature in the powder is that it attracts moisture less than powder of the old pattern. Experiments made with the 40 centimetre gun of 25 caliber length gave as good results as those above quoted. These experiments were made in 1882.

The pamphlet for 1883 contains data from tests with guns of various sizes. Among them we observe, that in the 28 cm. gun of 35 calibers length, with a projectile weighing 345 kg., 100 kg. of C/82 powder gave a muzzle velocity of 525 metres and a pressure by the Rodman gauge of 2325 atmospheres, and by the crusher gauge 2350 atmospheres. Both pamphlets contain tabulated results of many trials.

It has been tried in Russia in small arms, and in France in large grains, and is reported to have given good results. A resumé of some of the firing trials will be found in the *Revue d'Artill.*, 21, 77 and 475, 1885.

In the *Four. Roy. United Service Inst.*, 28, 379, 1884, under the subject of "Gunpowder considered as the Spirit of Artillery," Col. Brackenbury, R.A., says that two

firms in Germany are making the above-mentioned powder, one calling it Cocoa and the other Brown Powder. The proportion of sulphur in its composition is small, and the charcoal, if we may so call it, is different from that generally made. When first brought forward it was irregular in its action, but later samples have given very good results, about the same as Waltham Abbey C₂, and with a less amount of powder. They are prepared to make it at Waltham Abbey if its value is established, but some claimed that its erosive action is too great.

Considerable space is devoted to the subject of blending powders, and cuts are given illustrating the method followed. In this connection he says an idea has lately been set afloat that this process can be got rid of and powder made so regular that it will need no blending, but up to the present time there appears no prospect of any such consummation. Gunpowder is such a nervous and sensitive spirit, that in almost every process of manufacture it changes under our hands as the weather changes. Sometimes its sensibility can be detected and allowed for, as in the process of pressing it into moulds, when we can by actual trial tell what densities we are getting, and give more or less pressure as is required. For instance, on the morning of the 13th June, 1882, the pressure had to be applied for forty-five seconds to obtain the required density. Later in the day only twenty-nine seconds were required to obtain the same density, so that in the morning of a June day half as much time again was required as in the afternoon. On the 30th June, 1882, during part of the day the time was as short as twenty-six seconds; on the 11th December the time varied between 98 and 84 seconds to get the same density

as was obtained in June. In the other stages of manufacture we have no such indications as in the pressing process, but it is a fact that not only the warmth of summer and the cold of winter affect it greatly, but the morning mists, the sunshine of midday, the dews of evening, yea, even a passing cloud, tell upon its nervous temperament. As a mitigation of the weather difficulty, they are to try warming a set of houses with warm water.

Under the title "A Flashing Test for Gunpowder," Charles E. Munroe discusses in the *Four. Am. Chem. Soc.*, 6, 7, 1884, the merits and defects of the method in use as described in the "Ordnance Instructions U.S. Navy," p. 345, and Smith's "Handbook of the Manufacture and Proof of Gunpowder," p. 83, and the suggested improvement of Marvin in his "Objects and Resources of the Naval Experimental Battery," p. 18, and also the pyrographic method invented by Colonel Chabrier, and described in the *Comptes Rendus*, 78, 1138, 1874, and the *Revue d'Artillerie*, 4, 396, 1874. He then describes his own process, which consists in flashing the powder on a sheet of dampened paper which has been coated with Turnbull's blue—in fact such blue paper as is produced in the "Blue Print Process" of photography. The result will be that if the paper is washed, after a half minute exposure to the action of the powder residue, it will be found covered with yellowish or white spots, that have been caused by the action of the alkaline salts which result from the combustion, and which have the power to discharge the blue colour; and the author holds that the fineness of the spots and the uniformity of their arrangement about the explosive centre are determined by the thoroughness of the incorporation of the powder.

The advantage which is claimed for this new method is, that as the test-papers, when dried, remain unchanged for years, they may be filed at the factory with other data concerning a given powder, or that, in the case of the government, they could be inclosed with the quarterly returns of the inspecting officers at distant stations, to be examined by some expert in the Bureau. Specimens of the tests of standard powders could also be furnished inspecting officers, to guide them in the interpretation of the results of their tests, and finally, a sample of the required test might be attached to the specifications for a gunpowder to be purchased. A detailed account of the method can be found in the "Text-book of Ordnance and Gunnery, U.S.N.A.," p. 93, 1884, and *Van Nostrand's Eng. Mag.*, 32, 427, May, 1885.

We are in receipt from Luckhardt and Alten, Cassel, Germany, of a thin pamphlet, entitled "A Few Words on the Present State of the Manufacture of Gunpowder," in which it is claimed that the German gunpowders are now superior to those of all other countries, and are largely purchased by foreign governments, and that the superiority is due solely to the severity of the tests applied to the materials and the manufactured product, and to the delicacy and accuracy of the instruments employed in making these tests. The pamphlet then describes, with illustrations, a considerable assortment of apparatus which this firm supplies, and among them, besides the densimeters, chronographs, pressure gauges, and the like, we especially note an apparatus for measuring the length of cylinders in crusher gauges, which it is claimed will measure a difference of one-fortieth of a millimetre (one-thousandth of an inch), another for measuring the length of cut in the Rodman method, which will read to the one-hundredth millimetre (one-2500th of an inch), and another still for measuring the thickness of wire and width of mesh in metallic powder sieves, which also reads to the one-hundredth millimetre.

The newspapers for some time past have contained notices of the dynamite gun now on trial at Fort Hamilton. One of the fullest descriptions, with an illustration, is to be found in the *Scientific American*, 50, 214, April 5, 1884. This represents the 4-inch gun building at the Delametre Iron Works, N.Y. It consists of

a brass tube, forty feet in length and a quarter of an inch thick, mounted on a high steel girder. The latter is trunnioned and is pivoted on a cast-iron base, thus enabling it to be swung into any desired position and range. To assist in the latter operation guys are placed on either side of the base, and their length can be altered and fixed by means of hand-wheels.

Compressed air is introduced to the gun from below and passes up through the centre of the base, the pipe connecting with one of the trunnions (which are hollow); it is then carried into a pipe at the side of the gun which leads into the valve. This valve is a continuation of the breech of the gun, with which it is connected by a short passage.

An important feature of the system, and one upon which the success of the undertaking greatly depends, is the projectile, or dart. It consists essentially of two parts, and while several different modifications have been tried, the principal features are alike in all of them. The forward part of the dart consists of a thin brass tube, into which the charge of dynamite is inserted. At the rear the tube is enclosed by a wooden plug, which flares out towards the rear until its diameter equals that of the bore of the gun. The forward end of the brass tube shows a mass of some soft material, into which is inserted a pin firmly held in place, the end being closed by a conical metal cap. Provision has also been made to allow a certain amount of air to act as a cushion for the dynamite cartridge, thus lessening the shock due to a sudden discharge. It is therefore claimed, that under ordinary circumstances there is little danger of the charge exploding, since the pin cannot reach it and ignite the fulminate at its end; but when thrown from the gun, the impact against a body will displace the soft material and drive the pin home, causing an explosion. Another feature of the projectile is the power which it possesses to correct, to a certain extent, the deflection due to a side wind. It will be noted, that with the present construction, the centre of gravity of the dart is some distance forward of its centre of figure. A side wind acting upon the lighter rear part would therefore have the tendency to deflect it so as to turn the head of the dart into the wind, which action would, in a measure, tend to keep it in the line of its trajectory.

The firing of the gun, if the expression may be used, is accomplished in the following manner: The dart is inserted in the breech, and a gas check placed in position; a lever then being moved, the valve is opened and the air pressure admitted. This method of discharge will, it is thought, obviate the danger of the shock, which had heretofore proved a stumbling block to success; and in addition, the valve-controlling action is automatically arranged to admit the air, gently at first to overcome the inertia of the projectile, following with full pressure, and finally closing at the proper time as the dart leaves the gun.

Experiments made thus far have shown that the apparatus can be depended upon for a fair degree of accuracy and rapidity in firing. As regards the range attainable, the two-inch gun now being tested has attained 1½ miles with a pressure of 420 lbs. to the square inch. In the four and six-inch gun which are in course of construction, it is intended to use pressures of 2000 pounds and over, by the use of which they hoped to attain a range of three miles. Advantages claimed for these guns are lightness and ease of manufacture.

The *Washington Sunday Herald* of March 17, 1884, states that the experiments with dynamite shells have proved less efficient than was anticipated, as they have no penetration, and the explosion takes place on striking. The issue of March 30 narrates that a workman at the Delametre Works tried the 4-inch gun with a piece of cotton waste. Although only a 100 pounds pressure was put on, the waste was blown through a wooden door two inches thick, making quite a large breach.

The idea of employing the expansive force of steam, or

of compressed air, for propelling projectiles is not a new one, but its application has not heretofore met with success, since penetration has been sought for. Among other contributions to the subject is a paper "On the Numerical Expression of the Destructive Energy in the Explosion of Steam Boilers, and on its Comparison with the Destructive Energy of Gunpowder," by G. B. Airy, *Phil. Mag.* [4] 26, 329, 1863. He reaches the conclusion that the destructive energy of one cubic foot of water, at the temperature which produces the pressure of 60 pounds to the square inch, is equal to that of one pound of gunpowder.

In Richardson and Watts's "Chemical Technology," vol. I., Part iv., p. 523, London, 1865, we also find the following:—"High pressure steam is exceedingly well adapted to the performance of this kind of work; unluckily it would require high-pressure steam of 400 atmospheres or 5000 lbs. pressure on the round inch to perform this duty, and as such steam could only be generated in a furnace intensely heated, it is scarcely probable that boilers will be found sufficiently strong and durable to work continuously under such pressure. If they were found to be practicable, nothing more would be necessary than to bring a steam-pipe from the boiler to the breech of every gun in a fortress or a ship, and the admission of the charge of such steam into the chamber by a valve would be sufficient to discharge the missile of the 68-pounder with a speed of 1600 feet a second. The well-known Mr. Perkins studied this subject carefully, but applied it somewhat differently. He found that steam of this pressure could be generated only by water nearly red-hot; and instead of throwing the steam into the breech by a pipe, he threw the red-hot water into the breech of his gun, allowing it when there to expand itself into steam and expend its force in giving speed to the ball. This expedient of Perkins is well worthy of study. It has both the defects and advantages of a gunpowder gun. The red-hot water thrown into the barrel would have the fault of being too powerful at the beginning of its expansion and too weak at the end. The barrel would be filled partly with water and partly with steam; and as the water grew into steam it would lower its temperature and its pressure, so that the explosive force would fall off very much towards the end of the stroke. This is the inevitable evil of allowing the water to become vapour in the gun. When the steam is generated in a separate boiler, and freely admitted into the breech of the gun, there is reservoir enough of heat and steam to maintain the even pressure in following up the ball from the breech to the muzzle. It is the evil of charges converted into gas within the breech of the gun, that their temperature and pressure are too high at starting and too low at the end. The steam-gun would in this respect be the best of our projectile forces.

"Compressed air has many of the advantages and some of the defects of steam; and the frequent use of the air-gun has shown its convenience as well as its efficiency. Air can be compressed into a reservoir by mechanical force, just as steam can be raised in a boiler by heat; and by compressing 400 times the natural quantity of air into a given space, a pressure of 400 atmospheres might possibly be obtained in this way. If an air-pipe communicated from this reservoir to the breech of our gun, air of 400 atmospheres of pressure would certainly be able to follow up the 68-pounder shot, with pressure and velocity able to discharge it with a speed of 1600 feet per second, and, therefore, to do our work; but the apparatus would be full of mechanical difficulties.

"Liquid gases are known to be receptacles of enormous mechanical power. Carbonic acid gas, liquefied and shut up in a reservoir, generates large volumes of gas with great rapidity the moment it is permitted to expand. Other gases expand with still greater rapidity and force; and if we could conceive liquid gases to be easily made, safely carried, and comfortably handled, a charge of liquid gas bottled up in the breech of a gun would be a very effectual propelling power, and quite able to generate the

force we want, and to apply it within the time we require. This system, however, is also beset with mechanical difficulties.

"The preceding illustrations of steam, compressed air, and liquid gases lead us on very instructively to the manner in which fire has become necessary to do the work of a gun. A supply of heat is essential to the expansion of a gas, and a rapid supply is indispensable to the rapid performance of the work. In steam, the fire is not only external to the gun, but external to the boiler in which the steam is generated. In gunpowder, the fire is introduced into the inside of the gun, for the purpose of supplying the heat that is wanted to raise the gases to their elastic pressure, and to maintain them at that pressure while expanding. Red-hot steam introduced into the breech of a gun rapidly cools down and loses its heat and power in expanding. If we could introduce fire into the breech of the gun at the same time, to maintain the heat of the steam and the water, the steam would become an admirable propelling force. Carbonic acid gas expanding rapidly from the liquid into the gaseous state cools down so suddenly as not only to lose its mechanical power, but to freeze into solid flakes of snow. If we could charge the breech of the gun with fire as well as with liquid gas, the fire would give it the heat it wants, prevent its congelation, and maintain its power to the end of the discharge. What gunpowder and gun-cotton do is really to provide a reservoir of gas and a fire to heat it simultaneously and in the same chamber. In the case of gunpowder the fire is fed with charcoal, in the case of gun-cotton the fire is fed with gun-cotton wool—another form of carbon. In gunpowder large quantities of carbonic acid gas are generated, possibly in the liquid state, and are heated by the internal furnace of the charge, possibly red-hot. In like manner in a gun-cotton charge, red-hot water or steam is introduced with other gases, possibly also liquids, together with an internal furnace of flame; and thus the work is done—first, by the release of the gases themselves, and, secondly, by the continuance of the elasticity of those gases by the internal supply of heat. This is how gunpowder and gun-cotton really do the work of a steam-gun, a carbonic acid gun, or any other kind of gas-gun."

CORRESPONDENCE.

GELATINOUS MATTER IN LARD.

To the Editor of the Chemical News.

SIR,—I notice in your last issue a letter by Mr. A. P. Smith, in which reference is made to one of mine on the presence of gelatinous matter in lard. Allow me to observe that in order to verify my statement I submitted a sample of the lard to two of the most distinguished chemists in this city, *viz.*, Dr. Campbell Brown and Mr. Norman Tate, who concurred with me that the lard contained water and gelatinous matter, but objected to my hypothesis that the gelatinous matter had been added fraudulently. Upon consideration, and under the impression that in the Western States the whole of the hog is, with the exception of the hams and bacon, rendered down for lard, I came to the conclusion that the presence of the gelatinous matter might be attributed to the action of alkali* upon fatty tissue left in the lard by the original melters.

Lard as met with in commerce (according to my experience, which extends over the refining of fifty thousand tons) is made from all the fatty tissues of the hog, and its melting-point varies in direct ratio to its consistence, the greater the consistence the higher the melting-point. Lard, as imported from the United States, begins to

* Used in refining.

solidify at temperatures ranging between 78° and 87° F., and sometimes at a much lower temperature, but when it is submitted to pressure the temperature of solidification rises in direct ratio to the pressure, until the solidifying point of stearin is attained. I have before me a sample of lard which has been subjected to a pressure of 150 atmospheres, but this will not melt at anything like the temperature at which lard melts. Of course you will say that this is not lard in its normal condition, and I shall agree with you. But such is the public taste for firm lard that the refiner is obliged to press hundreds of tons of lard in order to cater to it. The oil so produced at times has to be sold at considerable loss, and is used as a lubricant for machinery, for which purpose it is one of the best. For my own part I regard the use of lard oil as a lubricant for machinery as a downright waste of food. When freshly pressed it is as sweet in odour and flavour as any connoisseur could wish, and I am astonished that it is not used more extensively by the practical cook.—I am, &c.,

WILLIAM BROWN.

3, Hereford Road, Seaforth, near Liverpool,
October 19, 1885.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 14, Oct. 5, 1885.

Spectral Analysis of the Elements of the Atmosphere.—J. Jansen.—The study of the spectral properties of the gases and vapours which constitute the earth's atmosphere is one of the most important subjects of astronomical physics. It forms one of the principal bases upon which Science founds its conclusions on the composition of the planetary and stellar atmospheres. Our knowledge of the absorption-spectra of even the principal gases is still very imperfect. We have arranged at present at the observatory of Meudon four tubes, one of them 60 metres in length. Hydrogen, atmospheric air, and oxygen are under examination. Oxygen is being studied in tubes of 20 and 60 metres long which can support high pressures. When in the 60-metre tube we set out with low pressures which are gradually increased, we observe the successive appearance of rays or bands more and more numerous. These are at first the rays and bands of the red, which M. Egaroff considers as being the rays A and B of the solar spectrum. But on increasing the pressure up to 27 atmospheres, and also the power of our source of light, we have been able to observe phenomena of absorption beyond A. Between A and B and B and C there appear to exist rays which require a still higher pressure to be established with certainty. We have seen appear three dark bands, one in the red, near α ; one in the yellowish green, near D; and one in the blue. The solar spectrum does not present similar bands; it will therefore be difficult to ascribe to oxygen, in the state in which it exists in the earth's atmosphere, the existence of these bands.

Thermic Studies on the Aromatic Series: Phenols of a Complex Function.—M. Berthelot.—The author has experimented upon anisic acid, methyl-salicylic ether, benzyl-aloformic acid, vanilline, vanillic acid, piperonal, piperonylic acid, piperic acid, veratric acid, anisic aldehyd, anisic alcohol, alcohol, anisol, anethol, salicine, eugenol, and tolueno-sulphuric acid.

Journal für Praktische Chemie.

New Series, Vol. xxxii., Parts 1, 2, and 3.

The Action of Ethoxalyl Chloride upon Derivatives of Urea and Guanidin.—M. v. Stojentin.—Ethoxalyl chloride so acts upon diphenyl-sulph-urea that it becomes split up into carbonic acid, and chlorethyl gives off carbonyl, which latter takes the place of anilide, and of a hydrogen atom, which, combining with the anilide, forms aniline. Thus arises, with participation of 2 mols. diphenyl-sulph-urea, the compound thio-carbanilido-thio-oxanilide. The reaction of ethoxalyl chloride upon mono-phenyl-thio-urea is that from 2 mols. of the latter the elements of 1 mol. ammonia are eliminated, whilst two hydrogen atoms are replaced by oxalyl, forming the compound oxalyl-diphenyl-dithio-biuret. On treating mono-phenyl-urea with ethoxalyl chloride there are formed, simultaneously, phenyl-carboxethyl-urea in quantity, and as by-product mono-phenyl-oxalyl-urea. With diphenyl-urea, ethoxalyl chloride yields diphenyl-parabanic acid, oxalyl being substituted for two hydrogen atoms of diphenyl-urea. Upon triphenyl-guanidin, ethoxalyl chloride acts in such a manner that two atoms of hydrogen in the guanidin are replaced by carboxyl, forming carbonyl-triphenyl-guanidin hydrochlorate.

Influence of Neutral Salts and of Temperature in the Inversion of Cane-Sugar by Acids.—J. Spohr.—The author undertakes a more thorough examination of this subject than that carried out by Löwenthal and Lenssen. The results appear in the form of tables.

Benzyl Ethers of Bromised Nitro-phenols, and their Behaviour on Reduction.—G. Roll and O. Hölz.—The authors describe the preparation of the benzyl ethers, the properties of mono-brom-ortho-nitro-phenol-benzyl ether, of the corresponding dibrom-compound of mono-brom-para-nitro phenol-benzyl ether, the corresponding dibrom-compound, and the reduction of the benzyl ethers.

Para-brom-ortho-amido-phenol.—Dr. F. Schütt.—This compound forms faintly yellowish needles, soluble in the cold in alcohol, ether, and benzol, and with the aid of heat in water, chloroform, and carbon disulphide. The last-mentioned solution deposits, on cooling, fine leaflets. The melting-point is 128°. The aqueous solution of the needles, even if much diluted, is coloured red by ferric chloride. A brownish red mud is deposited on long standing. The author next describes the hydrochlorate, hydrobromate, nitrate, sulphate, and two acetic compounds.

Brom-amido-phenols.—Otto Hölz.—An account of ortho-brom-para-amido-phenol, its hydrochlorate, chlorostannate, sulphate, and hydrobromate; ortho-brom-aceto-para-amido-phenol, di-ortho-brom-para-amido-phenol, di-ortho-brom-aceto-para-amido-phenol, ortho-para-di-brom-amido-phenol, and ortho-para-dibrom-aceto-ortho-amido-phenol.

On Meta-phenetidine.—P. Wagner.—In a free state this base is a clear yellowish liquid, which at a pressure of 100 m.m. distils over, unchanged at 180° to 205°. If exposed to the air it quickly darkens. The author describes the tin double salt, the hydrochlorate, hydrobromate, sulphate, oxalate, and acetate. He then proceeds to describe certain derivatives of meta-phenetidine, meta-diazo-phenetidine, and meta-phenetidine-azo- β -naphthol-sulphonic acid, dimethyl-phenetidine, and nitroso-dimethyl-meta-phenetidine.

Calorimetric Researches.—F. Stohmann.—These include determinations of the specific heat and fusion heat of myristic acid and lauric acid, by F. Stohmann and H. Wilsing, and on the combustion heat of lauric and myristic acid, by F. Stohmann and P. Rodatz.

On Fulminuric Acid.—A. Ehrenberg.—Not adapted for useful abstraction.

On Chloro- and Bromo-fulminuric Acid.—A. Ehrenberg.—The former of these compounds forms a

dazzling white crystalline mass, readily soluble in alcohol and ether, but insoluble in carbon disulphide, petroleum, ether, and benzol. It dissolves also in water, but after a time it turns yellow, and, if heated, brown, evolving gas and depositing a yellow oil of a pungent odour. The corresponding bromine compound is very similar in its reactions, but it is less readily decomposed by cold water.

On Picryl-sulphonic Acid and its Sodium Salt.—C. Willgerodt.—This acid has a double-melting-point. It fuses first at about 100°, and then re-solidifies and melts for the second time at 185°. It is readily soluble in water, alcohol, and ether, from the two last of which it separates in needles or in long thin prisms.

The Question of the Connection between Molecular Structure and the Phenomena of the Absorption of Light.—M. von Klobulow.—The most important fact here laid down is that the spectra of the permanganates evince no phenomena of absorption in the blue, the violet, and the ultra-violet.

On α - γ -Dimethyl-chinoline and the Synthesis of Cincholepidine.—C. Beyer.—A preliminary communication.

On Melanurenic Acid.—M. Striegler.—This acid forms with bases two series of salts. With phosphorus pentachloride it yields phosphorus oxychloride and cyanurchloride. With other reagents it shows itself indifferent.

Archives Neerlandaises des Sciences Exactes et Naturelles
Vol. xx., Part 1.

Theory of the Rotation of the Molecules in a Solid Body.—G. J. Michaelis.—A mathematical discussion incapable of useful abridgment.

Vol. xx., Part 2.

This issue contains no chemical matter.

NOTES AND QUERIES.

* * Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Phosphorus from Fossil Bones.—Could any of your readers inform me if, up to the present time phosphorus has been ever manufactured from fossil bones, phosphate of lime, or phosphuretted ironstone, like the ironstone of the oolitic and lias formation; and if in either case it has proved a scientific or commercial success; but particularly in the first-named case, *i.e.*, that from fossil bones?—INQUIRER.

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"As in the acid mixtures so here, a great many mutations are possible. Potassium chlorate may be partly (or perhaps totally) replaced by potassium or sodium nitrate. The liquid hydrocarbons mentioned above may be replaced either partly or totally by such which are not volatile. Fat, bitumen, rosin, or a solid hydrocarbon may be used of so low a melting-point that it becomes practicable to charge the oxidising cakes with them while in the fused state. As carbon in the form of charcoal, graphite, or diamond shows a different affinity for oxygen, so here the use of a hydrocarbon, or of any other combustible liquid *difficult* to inflame, will lower the tendency which compounds of potassium chlorate have to explode.

"At the conclusion of this introductory inquiry some allusion should be made to the aspect of the foregoing subject from a practical point of view. It is true that objections may be raised against the use of some of the foregoing explosives. The acid mixtures are hygroscopic and inconvenient to handle, on account of the corrosive properties of nitric acid. It is also not easy to find a suitable material out of which to make the cartridges. We have to choose between glass, stoneware, iron, and (when in the form of dynamite) perhaps paraffin-paper. Still it remains to be seen whether the advantages accruing from their use will not outweigh these disadvantages. In cheapness, power, and safety they compare favourably with other explosives now in use. The oxidising cakes or *grains*, when impregnated with oily liquids, are protected against the action of water. It should be borne in mind that nine-tenths of all explosives made (including common gunpowder) are used for blasting, and that the valuable properties of common gunpowder as a propelling agent are not required for mining operations. Here we want (with few exceptions) the strongest and the cheapest force. Hence my belief in a future for the above explosives. The great progress which of late years has been made in the manufacture of chlorine promises to lower the price of the chlorates, and nitric acid must always be cheaper than nitro-compounds.

"Lastly, though not least, to avoid the danger of a spontaneous explosion of these compounds during their manufacture, storage, and transport, *we can keep apart the oxidising from the combustible agent, until their chemical combination is to take place in obedience to the will of man.* I am aware that this way has been pointed out before, and has been abandoned as impracticable; but formerly both the oxidising and the combustible agents were solids. Now, however, we have two liquids, or a liquid and a solid, rendering their admixture easier.

"I feel justified in laying some stress on this point, as it appears to me to be the only path capable of conducting us through the operations necessary for the production and use of these dangerous explosives *in absolute safety.*"

The italics here are the same as those used in my paper of 1873.

It seems to me that Mr. Divine's numerous patents are the efforts of a legal mind anxious to surround by a fence a piece of ground which I acquired 9 years, 8 months, and 1 day before Mr. Divine appeared on the scene and gave to this now public property the quaint American name "Rackarock."

It is strange how much the fate of inventions is influenced by different times and surroundings. Between 1870 and 1874 I tried hard to introduce my inventions in explosives to the notice of those who by their calling one might have expected to have taken an interest in them. But all in vain; I received not the slightest encouragement—quite the contrary. Now, after the lapse of twelve years, these ideas begin to bear fruit,—though not in England and under my care.

I have no doubt that the recent success which attended the little earthquake in Hell-Gate will serve as a good testimonial. According to telegrams published in the *Times*, *Daily News*, and *Standard* of the 12th inst., it appears that the blasting charge at Hell-Gate was com-

posed of 107 tons of so-called "rackarock" and 33 tons of dynamite, equal in effect to about 600 tons of gunpowder. The more expensive dynamite, holding the detonator, was placed on the cheaper potassium chlorate charge,—in accord with my italicised statement of 1873:—

"Though the benzene mixture (without the sulphur) did not explode under the above conditions, the great similarity which exists between concussion and detonation suggests that substances which may be exploded by concussion may likewise be exploded by detonation sufficiently powerful. *In fact I found, that when I surrounded the percussion cap with an envelope of gun-cotton, its detonating power, thus strengthened or multiplied, had the effect of exploding in a most satisfactory manner mixtures of potassium chlorate, which contained neither sulphur nor a nitro-compound, such as benzene, petroleum, and phenol mixtures.* The practical significance of this fact is obvious."

From this it may be seen that General Newton, the Chief Engineer of the Hell-Gate Mine, took good care not to err in the direction of priming, for 33 tons of dynamite is a primer indeed.

In my opinion less dynamite would have sufficed to set off the rest of the charge. Still, it is gratifying to hear that my Safety Explosive had to do the main part of the labour in this the greatest explosion of its kind on record. By its force ceased to exist, at 11.13 a.m., "in obedience to the will of man" (in this instance in obedience to the will of little Miss Newton, who fired the shot) a rock which had covered an area of nine acres, and been the terror of mariners for many a long year.

May the force which accomplished this feat do further good service in the advancement of the works of peace!

London, October 26, 1885.

PLEA FOR THE EMPIRIC NAMING OF ORGANIC COMPOUNDS.*

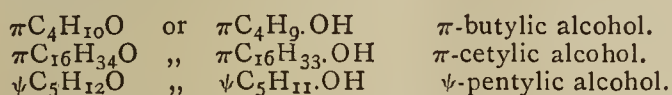
By WILLIAM ODLING, M.A., F.R.S.

(Concluded from p. 205.)

(12.) MOREOVER the system of naming bodies by distinctive prefixes according to their function and derivation, though insufficient to meet all cases, will yet carry us further than at first sight might appear. There are, for example, no fewer than thirty conceivable hexane or caprane compounds, referrible each of them to one or other of the three formulæ C_6H_{14} , $C_6H_{14}O$, and $C_6H_{12}O_2$. But having regard to the classification of the principal paraffins into di-methylic or normal, and tri-methylic or iso- (and of the little known tetra-methylic paraffins into the two sub-classes of neo- and meso-) and having regard also to the classification of alcohols into primary, secondary, and tertiary, it results that seventeen of these thirty compounds are capable of being readily designated without any recourse at all to structural names. Of these seventeen compounds, sixteen are known; whereas of the remaining thirteen compounds, the majority are unknown, while scarcely any of them are more than very imperfectly known. It is worthy of note that in every paraffin group there are only one normal paraffin, one normal primary alcohol, and one corresponding acid to be named; while associated with every iso-paraffin, are only one tertiary alcohol and from one to three primary alcohols, with their corresponding acids. And even though the possible isomerism *inter se* of the higher iso-paraffins, and of both normal and iso-derived secondary alcohols, is almost inconceivably great, it yet does not follow that every conceivable isomer will be found capable of identification and stable existence, while it is certain that the majority of them will be found of very small importance. Wurtz

* Read at the Aberdeen Meeting of the British Association, Sept. 11, 1885.

and other French chemists of his school associated the secondary alcohols with one another under the name of pseudo-alcohols. Acting on the suggestion thus afforded, the writer is in the habit of marking the names and formulæ of secondary alcohols and allied compounds with one or other of the Greek letters π and ψ , using π to denote secondary compounds deriving from normal paraffins, and ψ to denote secondary compounds deriving from the iso-paraffins; and here again the attribution of the prefix without further qualification would be taken to indicate the ordinary compound. It would suffice, for example, to speak of the mannite-derived alcohol or pseudo-alcohol as π -hexylic alcohol, notwithstanding the fact of there being another normal secondary hexylic alcohol comprisable within the same attributive designation. To name and formulate different secondary alcohols, &c., by the aid of these prefixed letters, as indicated below, may or may not, in different cases, fall short of adequately identifying them; but the so specialised name and formula does, in most cases, serve very well to express either all that we know about the nature of the alcohol, or all that we want to declare about it, supposing us to know much more:—



But while advocating the use of the letters π and ψ in this special sense, a protest must be made against the disposition shown by some chemists to limit or define in some or other way the use of the letters α and β . The proper function in chemical nomenclature of the letters α , β , and γ , used as prefixes, is to denote—most often to denote provisionally—isomeric differences of any kind whatsoever, and more especially such differences as, being unexplained, are incapable of being reduced to a systematic treatment. To confine the application of the letters α and β , as among olefines or halogen-derivatives, for instance, to those of a particular ascertained constitution, is to do away with the general usefulness of these letters as means of distinguishing isomeric bodies.* It is much as if some school of mathematicians, by assigning special relative values to x and y , should destroy the general algebraic utility of these letters as means for expressing any values whatsoever. As regards the sufficiency and usefulness of indicative letters, such as π and ψ applied to secondary, and τ applied to tertiary alcohols, &c., it is to be remembered that there are many bodies of which the nature as secondary or tertiary, or isoprimary or isosecondary compounds is satisfactorily made out, but of which little is known beyond. To bodies in this state of investigation the assignment of functional names is alone practicable, the assignment of structural names presupposing an ascertainment of structure. And in any case, no matter how full and assured may be our knowledge of the constitution of a complex body, it is altogether from the purpose of naming it, *i.e.*, of identifying it by a name, that we should endeavour to set forth in the name assigned to it all that we may know of its constitution. However, the position taken up in this pleading is not that structural names should be abandoned, but that they should be restricted to conditions wherein, and bodies whereto their application is either necessary or clearly advantageous. The subsidiary iso-paraffins, and the higher secondary alcohols, normal and iso-, are as yet but unimportant bodies, seldom requiring us to name them at all; while, as it fortunately happens, the general application of structural names to these classes of bodies is open to less objection than it is in most other cases.

* In much the same way, we are constantly obliged to forego the use of the particle "iso-" and word "primary" in a general sense, by reason of their having acquired a special sense, the former as applied to a class of paraffins and their derivatives, and the latter as applied to a class of alcohols. But since their specialisation in this way has become an established usage, and fulfils a real want, it can only now be submitted to; though it is to be regretted that the want was not met in the first instance by a resort to some other expedient.

(13.) As regards the method here advocated of distinguishing isomeric bodies from one another by a more frequent resort to significant letters or syllables prefixed to the names common to the different isomers, it is observable that the secondary iodide of propyl, $\text{CH}(\text{CH}_3)_2\text{I}$, may be spoken of indifferently as π -propyl iodide or iodide of pseudo-propyl, and be formulated synoptically as $\pi\text{C}_3\text{H}_7\text{I}$. And as in many cases it suffices to speak of π -propyl* instead of dimethyl-methyl, so in many cases it suffices to write $\pi\text{C}_3\text{H}_7$ instead of $\text{CH}(\text{CH}_3)_2$. Thus butyric acid, $\text{C}_4\text{H}_8\text{O}_2$ or $\text{CH}_2(\text{C}_2\text{H}_5)\text{CO}_2\text{H}$, being regarded as propyl-formic acid, $\text{C}_3\text{H}_7\text{CO}_2\text{H}$, isobutyric acid, $\sigma\text{C}_4\text{H}_8\text{O}_2$ or $\text{CH}(\text{CH}_3)_2\text{CO}_2\text{H}$, will appear as π -propyl-formic acid, $\pi\text{C}_3\text{H}_7\text{CO}_2\text{H}$, and so in other cases. But just as it suffices for the most part to speak of isobutyric acid instead of dimethyl-acetic acid, so it suffices for the most part to formulate the acid as $\sigma\text{C}_4\text{H}_8\text{O}_2$ or $\sigma\text{C}_4\text{H}_7\text{O.OH}$, instead of as $\text{CH}(\text{CH}_3)_2\text{CO}_2\text{H}$, or even as $\pi\text{C}_3\text{H}_7\text{CO}_2\text{H}$. It comes, indeed simply to this, that on the frequent occasions which arise for making use of empiric names and more especially of empiric formulæ for different isomers, it is more convenient to use the prefixed letters τ , π , and ψ , than the words tertiary, secondary, and iso-secondary, respectively. The prefix σ , selected to denote iso-paraffin derivatives, may, it is obvious, be commonly dispensed with in the case of secondary and tertiary iso-derivatives; the former being distinguished from secondary normal derivatives by substitution of the prefix ψ for π , while the prefix τ suffices of itself to indicate iso-tertiary compounds, there being no tertiary compounds derivable from normal paraffins.

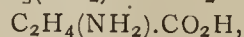
(14.) But even in the interest of the system of structural names, it would seem desirable that on the formation of new products synthetically; no less than on their extraction from particular sources serving to suggest their designation, they should, more frequently than has now become the custom, have empiric names assigned to them; and that the language of chemistry should be thus gradually enriched by new root-names such as ethane, naphthalene, phenol, aniline, isatin, glycocine, succinic acid, butyric acid, lactic acid, alizarine, &c. For the practicability of the whole system of structural names is dependent on our being able to employ combinations of root-names such as are involved in the expressions phenyl-propionic acid, di-ethyl-acetic acid, methyl-isobutyl carbinol, &c. &c. But suppose propionic itself to have no simpler name than ethyl-formic acid, or still worse, suppose ethane to have no other name than dimethyl, and phenoene than hexamethenyl, the result would be that a simple homologue of benzoic acid would require to be spoken of under the name of hexamethenyl-dimethyl-formic acid; and that from this already preposterous name, the derivative names of a host of products exceeding in their number and complexity those of benzoic acid itself, would have to be constructed, written, pronounced, and comprehended. It is indeed only by means of a good supply of short root-names that practicable structural names can be devised; and in view of the rapid growth of organic chemistry it seems most desirable to keep up the supply of such names. Some years back a new hydrocarbon was produced by the substitution of methyl for hydrogen in phenoene. Structurally, it was entitled to the name of tetra-methyl-phenoene; but it also had accorded to it with much advantage the root-name of durene, whereby, with the aid of the usual prefixes and affixes, its numerous derivatives were at once enabled to receive suitable and convenient functional names. On the other hand, we are acquainted with yet more important synthetically produced hydrocarbons, such as ethyl-phenoene, propyl-phenoene, di-phenyl, &c., which are practically without other than structural names, much to the hindrance of the satisfactory naming of their several derivatives. Methane and phenoene, by their different conjunctions, yield us dimethyl, better known as ethane CH_3CH_3 , methyl-

* Often miscalled iso-propyl; *vide par. 8*.

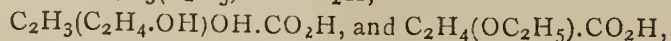
phenoene or phenyl-methane, better known as toluene $C_6H_5.CH_3$, and di-phenyl $C_6H_5.C_6H_5$, this last unfortunately not known by any other name, to the prejudice of our recognition of its importance, as a typical hydrocarbon—as the ethane, in fact, of the aromatic family of hydrocarbons. Who, moreover, can tell from the name itself, what is meant by such a name, for example, as diphenyl-acetic acid? Does it mean an analogue of dimethyl-acetic acid, with two proportions of phenyl replacing two of methyl; or is it an analogue of ethyl-acetic acid, with one proportion of diphenyl replacing one proportion of ethyl or dimethyl? Heretofore the structural formulation of bodies resulted from a late stage of their investigation, after they had become more or less familiarly known; but nowadays it precedes even their designation, with the result that in many cases they never get adequately designated at all.

(15.) The one undeniable advantage of structural names is that by their use we are enabled to identify different isomers from one another by significant differences in name. But what is to be said of certain quasi-structural names in which this advantage is altogether wanting, as is the case with those derived from familiar empiric names by addition of the prefixes hydro- and oxi- or hydroxi-? The use of the prefix hydro- is especially to be deprecated as contrary to all analogy and eminently confusing. If we speak, for instance, of bromo- or nitro- or amido-cinnamic acid, we mean ordinary cinnamic acid in which one atom of hydrogen is replaced by an atom of bromine, or pernitric oxide or amidogen. But if we speak of hydrocinnamic acid we mean ordinary cinnamic acid combined with two atoms of hydrogen. And if we want to mention the dibromo-derivative of this product, we have to call it dibromo-hydrocinnamic acid, notwithstanding that it contains no hydrogen whatever beyond that present in the original cinnamic acid.

(16.) The use of the prefix oxi-, or its equivalent, would seem to be not only warrantable but even necessary where it is intended to make certain comparisons, as between glycollic or oxi-acetic acid and glycolic or amido-acetic acid; between malic or oxi-succinic acid and aspartic or amido-succinic acid; and between lactic or oxi-propionic acid and ethyl-lactic or ethoxy-propionic acid, for instance. But if, when we merely want to speak of these different alcoholic acids by name, we are to abandon the familiar appellations of glycollic acid, lactic acid, malic acid, and tartaric acid, and are to speak of them only, or even preferentially, as oxi- or hydroxi-acetic, -propionic, and -succinic acids, as seems to be the intention of the Publication Committee of the Chemical Society, then, indeed, a strong protest against the introduction of any such practice would seem to be called for. No justification for its adoption is afforded by any real ambiguity or difficulty as to the naming of differently constituted derivatives of the alcoholic acids. For example, compounds represented by the formulæ $C_2H_3(NH_2)OH.CO_2H$ and



would, in accordance with custom, be distinguished as amido-lactic acid, and lactamic or lactamidic acid respectively. In the same way compounds represented by the formulæ $C_2H_3(C_2H_5)OH.CO_2H$,



would be distinguished as ethyl-lactic acid instead of ethyl-hydroxi-propionic acid, ethol-lactic acid instead of oxethyl-hydroxi-propionic acid, and ethyl-lactic acid or lact ethylic acid instead of ethoxy-propionic acid,—not that any objection is taken to this last as an alternative name, useful for the manifestation of particular analogies and relationships. That the acids of the lactic series differ from those of the acetic series in containing alcoholic hydroxyl in addition to the acidic hydroxyl common to the acids of both series, is, of course, undisputed. But it does not follow from this that the acids of the lactic series are to be called hydroxides instead of hydrates; or that they are to be named for general purposes either as

hydroxi-derivatives of acids of the acetic series, or yet as oxidised forms of these several acids. As to substituting the particle hydroxi- for the familiar oxi-, the innovation would seem to be a piece of pure pedantry. The use, in the names of derivative bodies, of the particles ethoxi-, methoxi-, &c., by no means demands the use of the corresponding particle hydroxi- in the names of the more typical bodies. It is well understood that oxi- stands for hydroxi-, just as it is understood that hydrate, cyanate, and sulphate stand for oxihydrate, oxicyanate, and oxisulphate. And, indeed, the use of the simple particle oxi- is as compatible with the use, when required, of the particle ethoxi-, as the use of the terms hydrate, cyanate, and sulphate without qualification, is compatible with the use of the terms sulphydrate, sulphocyanate, and thio-sulphate respectively.

(17.) The introduction, again, of the term hydroxide instead of hydrate is opposed to all analogy afforded by the established language of chemists in this country, and is further discredited by all continental usage. If we are bound to speak of ethylic hydrate as ethylic hydroxide, why ought we not to speak also of ethylic nitrate, sulphate, and oxalate as ethylic nitroxide, sulphoxide, and carboxide respectively? Simply because the use of the familiar terminations *-ate* and *-ite*, unless qualified in some particular way, has been held for more than a century to signify, and has been found sufficient to indicate, an oxidised state of the radical. As for making a distinction in meaning between the terms hydrate and hydroxide, that would be getting only still deeper into the mire. It may indeed be desirable or even necessary to have two words to designate the same thing, as conceived of in two different ways; but it is most undesirable, in devising names for a familiar class of compounds, to express a difference of nature between some and other of them, where no difference of nature is established to exist; and where, on the balance of evidence, it probably does not exist. It is manifestly allowable to speak either of mono-hydrated acetic acid, or of acetic tri-hydrate, meaning the same body regarded from a different point of view; but comparing mono-hydrated acetic acid with orthophosphoric acid, for instance, there seems no reason why, if the latter acid needs to be designated as a tri-hydroxide, the former does not require to be so regarded also. Similarly hydrated chloral, in respect to its state of hydration, would seem strictly comparable with ordinary oil of vitriol; and if the latter is to constitute a di-hydroxide rather than a hydrate, so should the former. If, again, we are to speak of ethoxide, phenoxide, &c., instead of ethylate and phenate, &c., why are we not to speak also of acetoxide, lactoxide, and salicyloxide instead of acetate, lactate, and salicylate respectively? But the sponsors for the word hydroxide do not even affect consistency in their recommendations as to its use. The individual alcohols are required to be designated as hydroxides, but the alcohols as a class, and presumably the alcoholic acids, are directed to be described as *n*-hydric rather than as *n*-hydroxic. The reasonable way is obviously to speak of these last as *n*-hydric, *n*-acidic, *n*-alcoholic, *n*-phenolic, &c., according to what is had in view at the moment; and similarly in the case of the allied amidic and ketonic acids. Lactic acid, for example, might be described as a di-hydric, mono-acidic, mono-alcoholic compound; salicylic acid as a di-hydric, mono-acidic, mono-phenolic compound; and malamic acid as a di-hydric, mono-acidic, mono-alcoholic, and mono-amidic compound.

The Use of Lakmoid as an Indicator in Alkalimetry.—C. Traub.—Lakmoid may be used as an indicator in alkalimetry. For this purpose 1 grm. is dissolved in 100 c.c. of alcohol mixed with its volume of water. To prepare sensitive paper we use a solution of lakmoid in 1000 parts of alcohol at 45 per cent, to which a few drops of caustic potash are added if it is wished to prepare blue paper.—*Moniteur Scientifique*.

ON THE GENERATION OF A
VOLTAIC CURRENT BY A SULPHUR-CELL
WITH A SOLID ELECTROLYTE.*

By SHELFORD BIDWELL, M.A., LL.B.

So far as I am aware there has never yet been constructed a voltaic cell having a solid electrolyte which, at least at ordinary temperatures, would produce the smallest indication of a current in the most delicate galvanometer. Sir William Thomson has described† a cell consisting of a piece of flint glass between plates of zinc and copper. After the glass had been warmed to 50° C. the plates were found to give indications of the existence of an electromotive force when connected with an electrometer. Profs. Ayrton and Perry have made similar experiments,‡ using paraffin-wax, gutta-percha, india-rubber, and shellac. But it is needless to say that with electrolytes of such enormous resistance as these no current could be generated which could be detected in the ordinary way by any galvanometer, however sensitive.

The present paper contains an account of some experiments with cells in which the electrolytes consisted of sulphides of silver and copper between plates of the same metals. In nearly every case these arrangements were found to be capable of generating sensible currents, which sometimes, indeed, measured several thousand micro-ampères, and were capable of producing deflections in coarse galvanometers with pivoted needles. Some of the results obtained are curious, and even opposed to what might have been expected, but they will, in general, be given without any comment or attempted explanation. The copper and silver plates used were in every case 3 c.m. square.

(1.) A cell was made by compressing a thin layer of powdered silver sulphide between plates of silver and copper. When connected with a shunted reflecting galvanometer this cell produced a deflection indicating a current of about 30 micro-ampères. The direction of the current was from copper through sulphide to silver. On the following day, the circuit having been open in the meantime, the cell generated a current of only 4 micro-ampères. The copper plate was found to have acquired a purple colour; the silver was untarnished.

(2.) The same cell was charged with equal parts of silver sulphide and sublimed sulphur mixed together. It now gave a current in the same direction of about 1·5 micro-ampères.

(3.) A layer of precipitated copper sulphide was placed between plates of copper and silver, which were squeezed together in a screw-press. When connected with the galvanometer (unshunted) this arrangement produced no deflection whatever.

(4.) The cell was re-charged with a mixture of 2 parts of copper sulphide with 1 part of sulphur, and when connected with the galvanometer it was found to give a very small current from silver to copper, indicated by a deflection of 2 or 3 scale divisions. The deflection was reversed as often as the connections with the binding screws of the cell were reversed, and the existence of a small electromotive force was undoubted. The internal resistance was 0·088 ohm.

(5.) Sufficient sulphur was added to the mixture to bring the resistance up to 2700 ohms. The cell when remade produced a galvanometer deflection which was at first about 100 divisions (indicating a current of 0·8 micro-ampère), but soon increased somewhat irregularly to 250 divisions. The direction of the current was as before, from silver to copper through the cell.

(6.) A plate of copper was heated, and upon it was spread a mixture consisting of 5 parts of sulphur and 1 of

copper sulphide. A plate of silver, previously heated, was laid upon the melted mixture, and the two plates pressed together. The thickness of the sulphur mixture between the plates was 0·3 m.m. When this cell, after cooling, was connected with the galvanometer the spot of light was at once deflected off the scale. Dr. Fleming was kind enough to make a very accurate measurement of its electromotive force by comparison with one of his standard Daniell cells. It was found to be 0·0712 volt., and its internal resistance was 6537 ohms.

(7.) A similar cell was made with a mixture of equal parts of sulphur and copper sulphide. Its internal resistance was much lower, being only 13 ohms, but its electromotive force was also lower, being 0·007 volt. This result agrees with those of (3), (4), and (5), in showing that the electromotive force is diminished when the proportion of sulphide to sulphur is increased.

(8.) Another cell was made in the same manner as the two last described, but the sulphur was mixed with silver sulphide instead of with copper sulphide. This gave a strong current in the same direction as that produced when copper sulphide was used, and opposite to the direction of the current generated by the cells (1) and (2). This reversal of the current may be accounted for by the fact that copper sulphide is formed when the melted mixture of sulphur and silver sulphide is brought into contact with the hot copper plate.

(9.) In order to ascertain whether sufficient sulphide to maintain a current could be formed entirely in this manner, pure sulphur was melted on a clean plate of copper, and, when just liquid, a warmed plate of silver was laid upon it, and pressed down by a weight until cold. The cell gave a strong current from silver through sulphur to copper.*

(10.) Thinking that the function of the free sulphur (without which, as has been seen, copper sulphide is incapable of generating a current) might be to form silver sulphide by contact with the silver plate, I constructed a cell as follows:—A thin layer of copper sulphide was laid upon a plate of copper, a polished steel plate was laid upon the sulphide, and the whole was strongly compressed in a vice. The steel plate was then removed, and a thin layer of silver sulphide was spread upon the smooth surface of the copper sulphide. The cell was completed by pressing a silver plate upon the silver sulphide. It gave a current of 240 micro-ampères through an external resistance of 3·5 ohms, the direction through the cell being from silver to copper. This form of sulphide cell seems to be exactly analogous in its action to a Daniell cell, consisting of plates of zinc and copper in solutions of zinc sulphate and copper sulphate. The quantity of the copper sulphide would be gradually diminished, copper being deposited upon the copper plate, while the quantity of silver sulphide would continually increase with consumption of the silver plate.

A similarly constructed cell, with plates 2½ ins. by 2 ins., gave a current of 2500 micro-ampères through an external circuit of 0·5 ohm.

(11.) Certain indications led me to believe that the cell last mentioned was short-circuited, and it appeared possible that this might be due to the penetration of particles of copper sulphide through the silver sulphide. The silver plate was therefore removed from the cell, and after being brushed over with a weak solution of sulphur in bisulphide of carbon, it was heated over a gas-flame, and soon became covered with a perfectly uniform and continuous coating of sulphide. The heating was continued until all the free sulphur was driven off.

* A thin layer of sublimed sulphur was compressed between cold plates of silver and copper, which were connected with the galvanometer. A deflection of 3 divisions was produced, indicating a minute current from silver to copper. The experiment was repeated several times with the same result. (Moisture in the sulphur would have caused a current in the opposite direction.) This effect can, I think, only be explained by supposing that sulphides were formed in small quantities and diffused through the sulphur; but little importance can at present be attached to it.

* A Paper read before Section B, British Association, Aberdeen Meeting.

† *Proc. Roy. Soc.*, 1875, xxiii., p. 463.

‡ *Proc. Roy. Soc.*, March 21, 1878, p. 222.

When the cell was re-made with this prepared plate it generated a current of 6800 micro-amperes through an external circuit of 0.2 ohm. The cell was found able to produce deflections in a roughly made galvanometer with a pivoted needle. Its electromotive force was 0.05 volt., and its internal resistance, therefore, was about 7 ohms.

Experiments with other metals would probably lead to the construction of a sulphur cell of greater power than any of those described in this paper. Silver may, indeed, be the best or only possible metal for the positive plate, but it is by no means certain that the copper of the negative plate might not be advantageously replaced by some other metal.*

ASSAY OF A GOLD ORE FROM THE VICINITY OF CONSTANTINOPLE.

By Dr. A. B. GRIFFITHS, F.C.S.,
Membre de la Société Chimique de Paris, &c.

HAVING recently made an assay of a gold ore from the vicinity of Constantinople the following remarks may interest metallurgical chemists:—

The gold is disseminated in very small pieces here and there throughout a quartz and earthy matrix. The ore comes from mines which have not been worked for several centuries, and were thought to be exhausted of gold. The assay both by dry and wet methods (of a carefully selected sample) gave 3 ozs. 14 dwts. of gold per ton of ore. The gold in the ore contains iron and copper and a very small quantity of silver. The matrix is composed chiefly of quartz, but contains calcium carbonate, ferric oxide, alumina, and lime.

Metallurgical Laboratory,
Technical School, Manchester.

NOTE ON WARINGTON'S MODIFICATION OF KJELDAHL'S PROCESS FOR THE DETERMINATION OF NITROGEN.

By H. B. YARDLEY.

WARINGTON states in his paper on Kjeldahl's process for the determination of nitrogen (CHEMICAL NEWS, vol lii., p. 162), that his first scheme for the removal of nitric acid by simple addition of water to the mixture of concentrated sulphuric acid and organic matter containing nitrates resulted in a loss of nitrogen, which loss he refers to as probably due to the action of nitrous acid on ammonia or amides. This explanation of the result may be correct where nitrates were originally present, but will not hold good in their absence.

As long ago as 1878 my attention was drawn to the fact that, when organic materials such as wool-dust and shoddy are heated with chamber acid (about 90° Tw.) until they are reduced to a black pasty mass, which was the plan for many years in use, for bringing them to a workable condition in manure making, there is a decided loss of nitrogen in the process.

In investigating the matter the following experiments were made:—

1. Equal weights of wool-dust and chamber acid (about 90° Tw.) were mixed together in a tubulated retort having its neck connected with a couple of cylinders containing solution of potash, and a gas-collecting tube and its tubulure with a carbonic acid apparatus. A stream of CO₂

* In a paper recently communicated to the Physical Society, which will be published in its *Proceedings* and also in the *Phil. Mag.*, experiments are quoted showing that the action of light diminishes the current generated by these sulphide cells, while heat increases it. Some very curious polarisation effects are also described.

was then passed to displace atmospheric air, and the contents of the retort heated on the water-bath until the organic material was completely disintegrated; CO₂ was then again passed to drive any gas evolved forwards into the collecting tube. Some quantity of nitrogen was thus found to be evolved in the gaseous state.

2. Similar quantities of wool-dust and acid were heated in a retort connected with a condenser and receiver. After the complete reduction of the organic matter, the retort was allowed to cool, more water added, and again heated to distillation. The distillate, having the odour and taste of SO₂, was neutralised with potash and evaporated to dryness, leaving a brownish residue which gave no nitrogen on combustion with soda-lime.

The foregoing experiments prove that the nitrogen is lost in the gaseous state, probably having been reduced by the sulphurous acid resulting from the carbonisation of the organic matters by the sulphuric acid.

ON THE PHENOMENA OF ABSORPTION IN ZIRCONS.*

By E. LINNEMANN

THE result of my investigation on the qualitative composition of the zircon from the Ural and from North Carolina made it seem desirable to examine the phenomena of absorption in zircon somewhat more closely.

It appeared that seemingly quite opaque crystals, such as the zircons of the Ural and of North Carolina, could be made available for examination in the state of thin sections. Such sections are found to be traversed by innumerable chinks, often tolerably wide, filled up with a brownish red, brown, or opaque mass, between which lies the main crystalline mass of the zircons, translucent or transparent, and of a red, brown, brownish yellow, or even light reddish-violet colour. This main mass differs in the shade and in the intensity of its colour, even in one and the same section.

Such sections cannot be examined with the light of an Argand lamp, as the illumination is insufficient. I therefore make use of a leaflet of zirconia at a white heat. This is ignited by means of a peculiar coal-gas and oxygen blast which I constructed some years ago, and to which I shall again refer below. With this apparatus a constant and very concentrated light can be obtained, varying at pleasure from 60 to 300 candles.

The section of a crystal of zircon from North Carolina, the main mass of which was moderately translucent, and of a reddish violet colour, and the section of a zircon from the Ural, the main mass of which was reddish brown, hyacinth-red, and yellowish brown in patches, both crystals of the kind and form which I had formerly worked up, agreed in showing a faint, but distinct, absorption-line at 86.5 of my scale, corresponding to the wave-length 6540.

This is the darkest of the sharp absorption-lines in the spectrum of erbium chloride which Lecoq de Boisbaudran mentions as Erβ, with the wave-length 6530 to 6540, and which Delafontaine also lays down in the spectrum of erbium chloride.

This erbium line appears also in the section of a zircon crystal from Brewig, in Norway, the main mass being of a brownish yellow colour.

On the other hand, no absorption appeared in the section of a very large zircon crystal from Renfrew, in Canada, with a red main mass interspersed with brownish yellow patches, nor in the section of another Ural zircon, which had a very different outward aspect. It was roundish, well developed all round, and with very many surfaces. The main mass was of a very faint yellowish colour, and comparatively very transparent.

* Reprint from the *Transactions of the Imperial Academy of Science*, vol. xcii.

			Er, Lecoq.	Di, Lecoq.	Tr, Delafontaine.
(1.) β at 80.5 of scale		$\lambda=685$	684	—	—
(2.) γ at 85 „	Very fine	659	—	—	—
(3.) α at 86 „	Sharp, very dark	654	654	—	—
(4.) „ at 93 „	Fainter	620	—	623	—
(5.) δ at 99.5 „	Fainter	592	—	—	—
(6.) 103—104 „	Faint, obsolescent	—	—	—	103—105 transferred to my scale.
(7.) 107—108 „	Shadowy	—	—	—	—
(8.) 116 „		535	—	539	—
(9.) 122—124 „	Faint	517	520	—	—
(10.) 137 „	Shadow broad	486	487	—	—

Next to the zircons just described come the so-called green and yellow zircons of Ceylon. They came into my possession in the form of flat pebbles. If these are cut and polished they appeared as clear as water, and in colour either of a fine grass-green, yellow, or brownish yellow.

These zircons also show the erbium line at 86.5, much stronger and broader, but vanishing away towards 85. These zircons also contain, without doubt, erbium, and certainly in considerably greater quantity than the zircons of North Carolina, of Brewig, and of the Ural. Many of the Ceylon zircons are slightly dichroic. The green ones display a broader erbium line, extending from 85 to 87 of the scale, and frequently also a faint absorption in the form of an obsolescent band extending from 99 to 100 of the scale. The transparent zircons can be most conveniently examined with the light of an Argand gas-lamp.

A greater number of absorptions appears in a certain kind of yellow Ceylon zircons, probably the sort known as "jargoons." Among five yellow pebbles from Ceylon I found one specimen of this kind, but I obtained the most characteristic specimen of this kind in the form of a polished and cut stone. Though both agreed fairly in their absorption-lines, the polished stone had a very high refractive power (higher than Canada balsam) and a strong fire: it was clear as water, and not more deeply yellow than a good Cape diamond. It displays the following absorptions:—

- (1.) 85 to 87 of scale, very strong, wave-length 660 to 648.
- (2.) 93 of scale, faint, wave-length 620.
- (3.) 99 to 100 of scale, distinct, wave-length 590 (middle).
- (4.) 115 of scale, faint, wave-length 537 (middle).
- (5.) 122 to 123 of scale, faint, wave-length 518 (middle).

Of these lines (1) corresponds to the erbium line $Er\beta$ (Lecoq); (2) Di (Lecoq, λ 623); (4) $Er\delta_1$ (Lecoq, $\delta_1=\lambda$ 536, $Er\delta_2=\lambda$ 541), Delafontaine Erh , and transferred from his scale to mine, 115; (5) Delafontaine's erbium band, Era , transferred to my scale, 121-123. Lecoq α , $\lambda=519$ (the last of the four lines given under α).

Of the five lines observed three, therefore, belong to erbium, one to didymium, and one (at 99 to 100) appears not to be identified.

The stone which I received as a pebble, named "yellow zircon from Ceylon," displays the following absorption-lines:—

- (1) At 80.5 of scale faint, $\lambda=685$; (2) 85 faint; (3) 86 very strong, $\lambda=654$; (4) 93 to 94 indistinct, faint; (5) 99 to 100 broad, indistinct, and faint. The lines (6) 115 and (7) 122 to 124 have the same properties.

Here, again, four absorptions, *i.e.*, 1, 3, 6, and 7, belong to erbium; one, *i.e.*, 4, to didymium, and two, 85 and 99 to 100, are not identified.

Next to jargoon, and displaying the greatest number of absorptions, come the so-called "violet zircons of Ceylon." They are distinguished from all other zircons by their peculiar hardness, which attracts notice in grinding. Although as clear as water when polished, they have a peculiar smoky appearance. They are of a pale violet

colour, almost like amethyst, and without exception strongly dichroic, with a dirty rose and a dirty yellow. I call, them, therefore, "zircon dichroite." Such stones have reached me as pebbles, but the first specimen was polished in the shape of a square pillar. It was mounted like crystals which were to serve as illustrations of dichroism, and was labelled "hyacinth, dichroism." As this column reached a thickness of 5 millimetres it was well adapted for optical examination. Of six pebbles of this kind all were dichroic, and displayed all the absorption lines. They are the following, the annexed letters showing the relative strength of the absorption-lines and bands in decreasing series:—(See Table above.)

Hence, of the ten absorptions observed, four belong to erbium, two to didymium, one probably to Delafontaine's terbium, and three lines are not yet identified.

The absorption-lines of uranium have not been observed in any of the zircons here examined. On the other hand, it may be due to the presence of uranium that the visible part of the spectrum extends neither very far into the red nor into the violet, since the strong absorptions of uranium are situate here.

Quite different from the spectra of the zircons here described is the absorption-spectrum of the Ceylon zircon specially known as hyacinth, whether they are really hyacinth-red, or, as it often occurs, garnet-red or ruby-red. They display no sharp absorption-lines, but broad, very dark bands, fading away on both sides. By their distribution in the spectrum they leave only portions of the red and the green, and cut off the yellow almost entirely. The spectrum shades away at $\lambda=530$ in the green part, and comes quite to an end at $\lambda=520$. The red part does not extend beyond $\lambda=690$. The erbium line at 86 of the scale has not been seen in any one of the many hyacinths examined, though there was a sufficiency of light for its perception.

Of the three lines of the "Ceylon zircon dichroite" not identified, that at 85 of the scale, $\lambda=659$, is identical with the line which I observed in erbium chloride prepared from zircon. It has not hitherto been traced to any of the known elements. The Ceylonese zircon dichroite is certainly the material the elaboration of which is most likely to solve the question as to the origin of the absorption-line $\lambda=659$, for this line appears in zircons from this source sharply marked along with the distinct erbium line $\lambda=654$, whilst these two adjacent lines appear confused together in the Ceylonese yellow and green zircons.

From the above results it will appear how important a service the spectral-analytic examination of minerals, even when obtainable only in the form of thin sections, may render in the discovery of their qualitative composition, and in finding materials for the study of those rare elements whose compounds possess absorbent properties, and concerning which we know hardly anything worth knowing.

A Modification of Kjeldahl's Method for the Determination of Nitrogen.—H. Hilfhart.—The author proposes to add to the sulphuric acid which serves for the destruction of the organic, a metallic oxide or salt, which much abridges the operation, saving seven-eighths of the time otherwise necessary. He gives the preference, for this purpose, to copper sulphate.—*Moniteur Scientifique*.

CHEMISTRY IN THE SERVICE OF PUBLIC HEALTH.*

In the service of sanitary science chemistry has an educational office to fill.

The public has very little conception of what the capabilities and limitations of chemistry are. It is hard to make a person believe that water to be analysed must be brought in a clean vessel, and that the chemist cannot distinguish between the impurities of the water and those of the jug. It is almost impossible for the chemically uneducated public to understand that when chemical action takes place the properties of the substances concerned are not carried into the product; that because vitriol is used in glucose factories the product does not contain the acid; and the use of aquafortis in making oleomargarin is equally startling.

There must needs be reformers and philanthropists, but many of these are extremists; and nowhere more than in sanitary matters is a little knowledge a dangerous thing. At one time all the evils were attributed to microbes, and at another to that which, as a definite and well characterised substance, existed only in the minds of the terrorists—the so-called sewer-gas. The microbes may be left to the biologist, and perhaps we may leave to them the emanations from ill-kept drains, since chemists have failed to discover any substances in the gaseous emanations which are capable of producing the effects ascribed to them. In the matter of food adulterations, the origin of the exaggerated statements is often obvious: thus, the statement that tea is adulterated with prussic acid no doubt arose from the use of Prussian blue in the facing. Chemists are periodically obliged to distinguish between those adulterations which are merely fraudulent and those which are actually harmful.

It is, perhaps, not altogether to our credit that we so often need the spur of extravagance to lead us to lay before the public the truth with regard to existing evils. An unvarnished statement of things as they really are cannot awaken that interest which arises when people imagine, after each meal, that they feel the effects of the alum in the bread, or the burning sensation of the vitriol in the glucose-adulterated sugar, or the heavy weight of the clay out of which the coffee-berries were moulded.

An important service rendered by chemistry to the public health is that of investigating the actual state of existing evils. The investigations made by the *Lancet* in 1851-54 into the character of the food sold in London were cited as an example of a case where action was not taken at the instance of extremists.

Another point where chemistry comes advantageously in contact with the public health, is in the suggestion of practical remedies for existing evils: some seem to believe that the proper method is, in all cases, to ascertain the existence of the offence, and then to order its discontinuance; but generally, where the evil has been long growing, and where large pecuniary interests are involved, such summary legislation is, as a rule, unjust.

The legislators should have in view some practical solution of the difficulty, which chemistry is often able to afford.

Professor Nichols stated that he had been asked, What is sanitary chemistry? Is it anything more than putting? as if the problems were all solved, and we had but to follow a mechanical process. There are, however, many problems still awaiting solution. Our knowledge of the normal composition of the atmosphere rests upon the analysis of many chemists; but, while we know so much, who knows the bearing upon health of the variations to which the atmosphere is subject? How much, in

spite of the work of Professor Remsen, do you know of the organic matter in the air, and the proper methods for its detection and estimation? Professor Remsen and others have found that the passage of carbon monoxide through the heated iron of our furnaces is practically of no account; but who can tell us of the composition and amount of the gaseous 'somethings' which make the anthracite-heated atmosphere of our houses so different from that of a house heated by a wood-furnace? It is asserted by some that the day of chemical examinations is passing away, and that the wholesomeness of water will be determined by the biologist, not by the chemist. Without detracting from the present value of biological methods, we cannot believe that they can replace chemical examination for a long time yet: it must first become certain that all the evil effects of impure water are due to the organisms now so eagerly studied. When the biological examination of water has been placed on a firm basis, it will then be necessary to carry out the work begun by Professor Mallet, of discovering the chemical characteristics which belong to waters which a biological examination condemns, and of making these characteristics the basis of future chemical analysis. In the matter of the pollution of streams by sewage, there is much chemical work to be done. The natural purification of streams is admitted to be a fact; but chemists differ as to the extent to which it takes place and the agencies at work. The action of oxygen has been and is to-day being studied; but clear light will not be obtained so long as we are content to speak of "organic matter" as though it were a definite something.

Sanitary science comes nearest to the public in the examination of foods and drinks. Chemical examination of such substances has long been provided for by law, and in recent years has seen greatly increased activity. Provision is made on the continent of Europe for such examinations; and there are laboratories at the service of the public, either gratis or under a tariff often ridiculously low. In this country, more or less stringent laws against adulteration exist; and these laws, in some States, have been made more stringent on account of popular feeling, which was at its height in 1878 and 1879; but the enforcement of such laws is usually in the hands of the State Boards of Health, which are often hampered by the want of suitable appropriations. As far as Professor Nichols was informed, no laboratories have been established by States or municipalities, where the public can have analyses made either gratis, or for a moderate fee; and it is doubtful how far the establishment of such laboratories is desirable. The laboratories which exist in connection with various educational institutions are probably all that is needed; and there are advantages in securing the co-operation of a number of able chemists, as is done in New York State, and in assigning to each certain descriptions of articles for analysis.

Investigations in sanitary chemistry have been undertaken in the various agricultural and physiological laboratories; but one of the first—if not the first laboratory specially founded for the investigation of these questions—was that established in Dresden, in January, 1871, under the direction of Dr. Fleck. Among subjects which have been investigated at this institution, are the various methods of water and food analysis, methods of protecting combustible and inflammable material, the effect of arsenical papers upon the air of rooms, the condition of the ground air in various localities, including cemeteries, the pollution of streams, &c. The State Board of Health of Massachusetts led the way on this side of the water, and the earlier reports of the board contain many papers on similar questions.

The education of those who propose to follow this line of work requires a thorough knowledge of general and analytical chemistry, and of physics. It is quite possible to take a bright lad from the grammar school, or even from the street, and teach him to make analytical determinations with great accuracy; but this does not make a

* Abstract of an Address delivered before the Section of Chemistry of the American Association for the Advancement of Science, at Ann Arbor, August 26, by Prof. W. R. NICHOLS, of the Massachusetts Institute of Technology, Boston, Vice-President of the Section, Communicated by the Author.

chemist of him. Courses in sanitary engineering in our technical schools have been established, but how far these courses will develop does not yet appear. In order that the student may have an intelligent idea of what questions should be submitted to the chemist, and how the results obtained should be understood, he should have a good knowledge of the principles of chemistry. Sanitary inspectors should be familiar with certain chemical tests which will enable them to make preliminary examinations and to determine how far the aid of a chemist is necessary. If there is room in the community for a class of persons knowing a little engineering, a little chemistry, a little biology, and a little of other things, the occupation is legitimate and honourable, but a person should not be called a sanitary engineer unless he is an engineer, or a sanitary chemist unless he is a chemist.

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Prof. CHAS. E. MUNROE, U.S.N.A.

(Continued from p. 212.)

PROF. R. H. THURSTON treats of the subject of steam in the *Journ. Frank. Inst.*, lxxxviii., 427, December, 1884, under the title "Steam Boilers as Magazines of Explosive Energy," and after referring to the above mentioned paper of Airy's, and that of Rankine "On the Expansive Energy of Heated Water," *Phil. Mag.* [4], xxvi., 1863, he has computed, by the aid of the formulæ of Rankine and Clausius, the magnitude of the quantities of energy residing in available form in both steam and water, for the whole usual range of temperatures and pressures familiar to the engineer, and also for those beyond, which have only been attained experimentally, but which are likely to be reached in the course of time, and he has plotted curves of the available energy of heated water, of latent heat, and of steam, and the explosive energy of many different forms of boilers.

The dynamite air-gun is also described with illustrations, and discussed by Chas. E. Munroe in *Van Nostrand's Eng. Mag.*, xxxii., 1, January, 1885, in a paper entitled "Some Recent Experiments on the Use of High Explosives for War Purposes."

In determining the efficiency of the air-gun projectile against an armour-clad vessel, the author assumes that one of four effects may be produced, depending on the resistance of the armour to penetration, and on the material, thickness of wall, profile, weight, and velocity of the projectile.

(1.) The projectile may either penetrate the armour partially and explode in place, or pierce it completely and burst inside of the ship. This is the condition of greatest efficiency.

(2.) It may explode immediately upon impact, and before breaking up. Then the explosive will exert the energy which it develops through explosion in a resisting receptacle.

(3.) It may rebound before exploding. Then the effect will be reduced by the interposed cushion of air.

(4.) It may break up on impact before the explosion takes place. Then the energy of the explosive will be simply that which it develops when exploded unconfined.

The resistance of an armour to penetration depends upon its hardness, its tensile strength (that due to bolting as well as that inherent in the metal itself), and its inertia.

The latter is augmented by the thickness and weight of the armour, and by the rigid system of bracing which now obtains in practice. How great this resistance is can best be illustrated by an example. While, from the fact

that very rapid progress is being made in the improvement of armour plates, we may have not chosen the best example, let us take the steel plates designed for the *Furieux*. One of these, weighing 23 tons 9 cwt., and averaging over 17 inches in thickness, was tested at Gâvre, July 13, 1883. Three shots were fired against this plate from a 12.6-inch rifle using chilled iron projectiles, weighing 759 pounds each. The first and second shot struck with a velocity of 1403 feet each. The third struck with a velocity of 1438 feet. The projectiles were all broken up, all of the twenty bolts through the plate remained intact, and no portion of the plate fell from the backing, although it was somewhat indented and cracked.

Although we are not yet informed concerning the air-gun projectile, except for the weight given above and the pressure of the air also cited, yet when we remember that in the Gâvre experiments the pressure of the powder gas probably approached 40,000 pounds to the square inch, it is not unfair to infer that with a pressure of 500 pounds to the square inch a projectile will possess little or no penetrative power against the *Furieux* plates at a distance of $1\frac{1}{4}$ miles. Whether then the projectile would explode on impact or after rebounding, or whether it would break up before exploding, is a matter for speculation and conjecture. If the last condition prevails, then we can judge from some experiments recently made at the Naval Experimental Battery what the destructive effect would probably be.

In these experiments Commander Folger detonated upwards of 400 pounds of dynamite, in charges of from 5 to 100 pounds, against a wrought-iron target, 11 inches thick, without damaging the plates. These charges were enclosed in cartridge bags and suspended against the plates. Commander Folger concludes from these experiments "that it is a matter which hardly admits of doubt, that a modern armour-clad will not be materially injured by the explosion, in superficial contact with her over-water plating, of charges of more than 100 pounds of dynamite."

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,

Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from page 210.)

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
- || Following a date signifies publication discontinued.

164. SCHOOL (THE) OF MINES QUARTERLY. Published by the chemical and engineering societies of the School of Mines, Columbia College, New York. 6 vols., 8vo. New York, 1879-'84+

SELMI, FRANCESCO.

See *Annuario chimico italiano*.

SCHWEIGER, J. S. C.

See *Allgemeines Journal der Chemie* [c.].

SEMBENINI, G. E.

See *Annuario delle scienze chimiche* [etc.]; also *Gazzetta eclettica di chimica tecnologica*; also *Gazzetta eclettica di farmacia e chimica medica*.

SIEBEL, J. E.

See *Chemical Review and Journal*.

SIMON, FRANZ.

See *Beiträge zur physiologischen und pathologischen Chemie*.

SKALWEIT'S REPERTORIUM.

See *Repertorium der analytischen Chemie*.

SOCIETIES, CHEMICAL.

American, see *Proceedings of the American Chemical Society*.

Chemical Industry, see *Journal of the Society of Chemical Industry*.

Columbian, see *Memoirs of the Columbian Chemical Society*.

* From the *Proceedings of the U.S. Naval Institute*.

As it is proposed to continue these notes from time to time, authors, publishers and manufacturers will do the writer a favour by sending him copies of their papers, publications, trade circulars, or expert testimony in infringement cases.

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

- Florentine, see* Orosi (L').
French, see Répertoire de chimie pure et appliquée.
German, see Berichte der deutschen chemischen Gesellschaft.
London, see Proceedings of the Chemical Society of London.
Public Analysts, see Analyst (The).
Russian, see Zhurnal russkova khimicheskova [etc.].
School of Mines, see School of Mines Quarterly.
- STAEDEL, W.
See Jahresbericht über die Fortschritte auf dem Gebiete der reinen Chemie.
- STÖCKHARDT, J. A.
See Chemische Ackersmann.
- ST. PETERSBURG.
See Zhurnal russkova khimicheskova [etc.].
- SVANBERG, L. F.
See Årsberättelse om Framstegen i Physik och Chemi [b.].
- SWITTAU'S REPERTORIUM.
See Repertorium der Chemie und Pharmacie.
- TABLEAU DU TRAVAIL ANNUEL (etc.).
See Introduction aux observations sur la physique [etc.].
- TAYLOR, RICHARD.
See Philosophical Magazine.
165. TASCHENBUCH FÜR SCHEIDEKÜNSTLER UND APOTHEKER. Herausgegeben von Ch. F. Bucholz. 8vo. Weimar, 1803-'19.
Cf. Almanach für Scheidekünstler und Apotheker.
166. TECHNISCH-CHEMISCHER KALENDER FÜR OESTERREICH-UNGARN. Jahrbuch und Notizbuch für den theoretischen und praktischen Chemiker, Fabrikanten, Bierbrauer, Branntweinbrenner, Zuckerfabrikanten. Herausgegeben von Paul Bennewitz. 2 vols., 16mo. Wein, 1875, '76.
167. TECHNISCH-CHEMISCHES GEWERBEBLATT. Gesammelte Vorschriften und Erfahrungen in der technischen Chemie. Zum Nutzen der Gewerbetreibenden und Fabrikanten, herausgegeben von L. F. Denzer. 1 vol., 8vo. Berlin, 1849, '50.]

(To be continued).

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 15, Oct. 12, 1885.

Neutralisation of the Aromatic Acids.—M. Berthelot.—The author's experiments, undertaken of course from a thermo-chemical point of view, relate to the mellic, the mercuric, and the acrylacetic acids.

On Various Phenols.—M. Berthelot.—The author considers that this investigation furnishes novel results, confirming the similitude of thermo-chemical action of the isomers of the same function. He has examined para- and ortho-cresylol, thymol derived from the oil of thyme, α and β naphthol, green quinone, and alizarin.

Observations on the Nature of Inverted Sugar and on Elective Fermentation.—E. Maumené.—The author holds that inverted sugar contains at least three varieties, and that it can no longer be considered as composed of equal equivalents of glucose and chylarose. As regards elective fermentation M. Maumené, in reply to an objection put forward by M. Leplay, maintains that the inverted-sugar used in his experiments was not mixed with normal sugar, but gave a deflection of at least 42° to the left.

Researches on Vanadium; Properties of Vanadic Acid.—A. Ditte.—Vanadic acid occurs in three distinct

forms, approximating to the three polymeric varieties of phosphoric anhydride discovered by MM. Hautefeuille and Perry:—1. Red ochrey acid, which absorbs moisture from the air and gives deep red hydrates soluble in water; the blood-red aqueous solution contains 8 grms. of acid per litre; it is modified by acids and salts. 2. A yellow form, not hygroscopic; this variety corresponds to red hydrates, sparingly soluble and yielding with water a light yellow solution, not modified by acids and salts, and which contains only 0.500 gm. of vanadic acid. 3. A crystalline acid, which does not combine with water, and almost insoluble in that liquid, which takes up per litre only 0.050 gm.

Moniteur Scientifique, Quesneville.
 Vol. xv., September, 1885.

Academy of Medicine.—Sitting of July 28th.—The papers read have no chemical bearing.

Patents taken out in France in the Chemical Arts.—A list of titles for the month of July.

Selection of Patents obtained and published in France in 1885 having reference to the Chemical Arts.

The Influence of Phosphates on Worts in Fermentation.—A. G. Salomon and W. de Vere Matthew. —From the *Journal of the Society of Chemical Industry*.

The Products of Putrefaction, their Chemical Composition, and their Relation to Disinfection.—Prof. Burdon Sanderson.—From the *Pharmaceutical Journal*.

The Illuminating Power of Methane.—L. T. Wright. —From the *Journal of the Chemical Society*.

The Illuminating Power of the Hydrocarbons.—Dr. P. F. Frankland.—From the *Journal of the Chemical Society*.

Solubility of Glass.—E. Bohliger.—From the *Zeitsch. f. Analyt. Chemie*.

Preparation of Pure Sulphuretted Hydrogen for Toxicological Researches.—Dr. Divers and E. Schmidzu. —From the *Journal of the Chemical Society*.

The Determination of Manganese.—W. Mathesius (*Chemiker Zeitung*).—The sample is dissolved in hydrochloric acid, and oxidised by means of bromine. The liquid is evaporated to dryness to eliminate silica. The residue is then re-dissolved in hydrochloric acid, and without filtration neutralised with ammonia. The iron is thrown down by adding an excess of zinc oxide; the liquid is made up to 1 litre, half of which is filtered, adding an excess of ammonia and ammonium chloride. The manganese is then precipitated by a current of air charged with vapour of bromine. The metal is thus precipitated in the state of peroxide free from zinc oxide. When the precipitation is finished a strong current of air charged with vapours of ammonia is made to pass through the liquid for ten minutes. The manganese peroxide is calcined and determined in the state of Mn_3O_4 . If the quantity is small the manganese is converted into sulphate by dissolving the peroxide into sulphuric acid.

The Determination of Reverted Phosphoric Acid, and of the Phosphoric Acid in Dicalcic Phosphate.—C. Mohr.—From the *Zeitschrift f. Anal. Chemie*.

The Volumetric Determination of Phosphoric Acid in presence of Alkalies, Calcium, Magnesium, Iron, and Aluminium.—J. Bongartz.—According to Thompson we may, by using phenol-phthalein or orange III. as indicators, determine phosphoric acid by caustic potassa. If to free phosphoric acid mixed with orange III. we add caustic potassa until the liquid turns to a brown, there is formed exactly KH_2PO_4 . On adding phenol-phthalein and potassa until a red colour appears, the monacid salt K_2HPO_4 is formed. We may, of course, utilise the liquid

in an inverse manner by means of a mineral acid. If we have a calcium salt the addition of potassa in an acid liquid until an orange-yellow is produced yields the monocalcic phosphate. The red colouration of phenol-phthalein indicates the formation of di- and tri-calcic phosphate, and of acid potassium phosphate. In presence of an excess of calcium chloride the monocalcic phosphate is transformed, by the addition of caustic potassa, into tri-calcic phosphate: 224KOH correspond to $142\text{P}_2\text{O}_5$. In presence of a sufficiency of phosphoric acid, iron and alumina are precipitated in the state of tribasic phosphates, insoluble in acetic acid. These phosphates, dissolved in hydrochloric acid, may be determined in a manner analogous to the calcium salt: 112KOH correspond in this case to $142\text{P}_2\text{O}_5$.

The Detection of Cyanides in Presence of Ferrocyanides.—W. J. Taylor.—From the *CHEMICAL NEWS*.

Use of Sodium Bicarbonate for the Disaggregation of Silicates.—M. C. Holthoff.—From the *Zeitschrift f. Anal. Chemie*.

Detection of Nitrous and Nitric Acids.—R. Warington.—From the *CHEMICAL NEWS*.

Analysis of Aniline Hydrochlorate.—Rowland Williams.—From the *CHEMICAL NEWS*.

Analysis of Vulcanised Caoutchouc.—C. Reinhardt.—The determination of the ash is effected by heating from 0.5 to 1 grm. in a covered crucible until the escape of gases is at an end. The cover is then removed, and the incineration completed, avoiding an excessive heat. To determine the proportion of mineral matters other than sulphur the weighed portion of caoutchouc in fragments is moistened with 20 c.c. nitric acid, spec. gr. 1.400, and heated in the water-bath until completely dissolved. The solution is then evaporated to dryness, moistened with hydrochloric acid and dissolved in water. The residue consists of barium sulphate and silica. The substances in solution (zinc, calcium, magnesium, iron, and aluminium) are determined by ordinary methods. To determine the total sulphur, 1 grm. is treated in heat with 20 c.c. nitric acid, adding gradually potassium chlorate until the oxidation is complete. Evaporate, dissolve in water acidified with hydrochloric acid, and determine the sulphuric acid in the usual way. The quantity of sulphur added for vulcanisation is determined by burning a sample at a low temperature in a current of oxygen, passing the vapours into hydrochloric acid containing bromine, and determining the sulphuric acid thus formed as barium sulphate.

Isochromatic Photography.—F. E. Ives.—From *Franklin's Journal*.

New Application of Electricity.—From *Engineering*.

Use of Sulphuric Acid in place of Nitric Acid to Oxidise Sulphides and determine their Metals.—Dr. E. Divers and Tetsukichi Shimidzu, M.E.—Apparently from the *Journal of the Chemical Society*.

The Tannates of Mercury.—C. Castelholz.—A purely pharmaceutical paper.

New Process for Detecting Caramel.—From the *Zeitschrift f. Anal. Chemie*.

Patent refused in Germany.—P. Monnet.—In this case the Berlin Patent Office, after the specification had been modified in accordance with their first objection, raised a second, not mentioned in their first communication, and refused the grant.

Analysis of Water used in Distilling.—Prof. Alois Schwarz.—The methods here given are thoroughly known.

The Question of the Purification of Water.—The water supply at Dunkirk is said to have been purified by some process not explained.

Biedermann's Central Blatt fur Agrikultur Chemie,
Vol. xiv., Part 4.

The Distribution of Phosphates in Bohemia.—J. Stocklasa.—The richest deposit mentioned is that from the tufas of the basaltic clefts near Tetschen, which contains 36.102 per cent of phosphoric acid.

Experiments on the Action of Sea-Mud on Moorlands and Sands.—Dr. M. Fleischer.—In the first year there was no result; in the second and third a very good effect, which declined again on the fourth.

The Influence of Outward Agencies on the Development of Animal Ova.—Rauber and Sachsse.—The development of hen's eggs ceases below 25° , and they can bear temperatures of 40° — 42° for a short time only.

Digestion of Cellulose in Horses.—V. Hofmeister.—The products into which cellulose is resolved in the digestive organs are of a gaseous nature, such as appear during the fermentation of cellulose.

Formation of Organic Acids in Presence of Potassa and Lime.—H. Leplay.—From the *Comptes Rendus*.

Oryza Glutinosa.—Prof. Kreusler.—This paper does not admit of useful abstraction.

On the Spread of Beet-Nematodes during the Season of 1884 in France.—Aimé Girard.—From the *Comptes Rendus*.

On the Proportion of Alkaloids in Various Species and Varieties of the Lupin.—E. Hiller.—A table of the proportions of the liquid and solid alkaloids present in the seeds of these plants. *Lupinus hirsutus* contains mere traces of alkaloid, and has no bitter taste.

Determination of the Water in Starch.—L. Bondonneau.—The author proposes the following process:—First, examine the acidity of the sample in question. If the starch has no acid reaction, 5 to 10 grms. are weighed in a glass capsule, which is then placed in a cold desiccation closet, and in about three hours the temperature is raised to 60° , and during the next hour to 100° , at which point it is maintained until no change of weight is found in two successive weighings. The heat may be raised to 110° . If the starch is disingly acid it must first be neutralised. For this purpose 5 or 10 grms. of the sample are weighed in a glass capsule. An equal weight of distilled water is added, and it is mixed with 1 to 2 drops of pure ammonia. It is then placed in a cold drying closet, the temperature of which is raised very slowly and not above 40° . The drying is then completed as above.

NOTES AND QUERIES.

* * Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Detection of Tar.—Will some correspondent kindly give details of any process he may know of for the detection and estimation of tar in heavy lubricating oils?—W. L. B.

MEETINGS FOR THE WEEK.

MONDAY, Nov. 2nd.—Royal Institution, 5. General Monthly Meeting. Society of Chemical Industry, 8. "Notes on the Chemistry of Soap," Dr. C. R. A. Wright, F.R.S., and Mr. C. Thompson. "On the Lime Process for the Purification of Coal Gas," by V. H. Veley.

THURSDAY, 5th.—Chemical, 8. "The Influence of Silicon on the Properties of Cast-iron. Part II.," by Thomas Turner. "Modifications of Double Sulphates," by S. U. Pickering, M.A. "The Relation of Diazo-benzene-anilide to Amidoazo benzene," by N. J. Friswell and A. G. Green. "The Phenol Constituents of Blast-furnace Tar from the Gartsherrie Iron Works," by Watson Smith, J. F. H. Coult, and H. B. Brothers. "The First Step in the Decomposition of Potassium Chlorate," by F. L. Teed.

TO CORRESPONDENTS.

E. C. O.—*Chemical Physics*.—The first volume of the new edition of "Miller's Chemistry."

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THE CHEMICAL NEWS.

VOL. LII. No. 1354.

NEW RESEARCHES ON THE COMPOUNDS OF DIDYMIUM.*

By P. T. CLEVE.

IN the year 1874† I published an account of an examination of didymium, free from all the other allied metals known at that time. Later on, however, it was found that didymium is accompanied by another metal, samarium. It is evident from the atomic weight of didymium, 147, as determined by me in 1874, as well as from the spectrum of didymium, mapped by Thalén,‡ that my didymium of 1874 was a mixture of the true didymium with samarium. My later determinations, in 1883,§ of the atomic weight of didymium, freed from samarium, gave the much lower number 142.3. It was therefore indispensable to repeat my former researches, and another reason for doing so was that I wished to determine the specific gravities of the pure didymium compounds in order to be able to compare them with the specific gravities of the compounds of the other rare-earth metals.

The material for this research was prepared by the method of partial precipitations of the mixed nitrates of didymium and samarium with cold dilute ammonia. The progress of the separation was tested by atomic weight determinations, and as soon as the didymium showed an atomic weight of about 142.3 it was regarded as sufficiently pure.

In working out this research I have been assisted by Mr. G. W. Petersson, assistant in the chemical laboratory of this University.

The specific gravity determinations were executed exactly in the manner described in my recent paper on the compounds of samarium.

The crystalline forms of several didymium compounds having been determined by Mr. C. Morton, student in the new University of Stockholm, I beg to offer him my best thanks. I have not made any determinations of the solubility of the compounds of didymium, as it is my intention to make a comparative study later on of the solubility of some of the salts of the rare earths.

Oxide of Didymium, Di_2O_3 .

The pure oxide of didymium has an ash-grey colour, and is easily soluble in acids.

Specific gravity—

2.5929 grms., temp. 13.5° , sp. gr. 7.177

2.5576 " " " " 7.182

Mean of both determinations, 7.179.

Molecular volume, 46.2.

Peroxide of Didymium.

On ignition to redness in the air the oxide of didymium assumes a dark brown colour, which disappears on heating to a bright red-heat. Marignac, Hermann, and Zschiesche have found that this oxide contains only a small quantity of oxygen more than the oxide of didymium (0.32 to 0.88 per cent). In the year 1874 Frerichs|| adopted the formula Di_2O_3 for the peroxide, supposing the oxide to be DiO . Later, 1878, Frerichs and Smith¶ give more de-

tailed accounts of their experiments. They then admitted the formula Di_2O_3 for the oxide and adopted the formula Di_4O_9 for the peroxide. This formula requires a large amount of oxygen (7.13 for 100 Di_2O_3). On repeating their experiments I* could not verify their statement, having obtained only 0.98 oxygen by heating the peroxide in a current of hydrogen. M. Brauner† also found only 1.22—3.55 oxygen for 100 Di_2O_3 , when he repeated the experiments of Frerichs and Smith. M. Brauner then tried heating the basic nitrate of didymium to incipient redness in a current of oxygen. On determining the oxygen as the loss by strong ignition he found as a mean of nine closely agreeing experiments 9.44 oxygen for 100 Di_2O_3 , which very nearly corresponds to the formula Di_2O_5 . However, the atomic weight of the didymium in the oxide, used by Brauner, was 146.6, which indicates that the oxide, regarded by Brauner as pure, really contained a large percentage of samarium, the atomic weight of didymium being 142.3, and that of samarium 150. I found it therefore necessary to repeat Brauner's experiments with the purest didymia I had. I heated the basic nitrate in a platinum basin till the red vapours ceased to be given off. The residue was afterwards powdered, heated again, and lastly heated in a current of oxygen to incipient redness. The material used for experiments 1 and 2 were obtained in this manner. In all the other cases I followed the description given by M. Brauner exactly.

My experiments are as follow:—

	Weight of the Peroxide.	Oxide of Didymium left by strong Ignition.	Oxygen on 100 parts Di_2O_3 .
1.	0.4744 grm.	0.4569 grm.	3.83
2.	0.6270 "	0.6060 "	3.46
3.	0.5278 "	0.5050 "	4.51
4.	0.5034 "	0.4823 "	4.37
5.	0.5984 "	0.5777 "	3.58
6.	0.5360 "	0.5198 "	3.31
7.	0.8788 "	0.8390 "	4.74
8.	0.9093 "	0.8658 "	5.02
9.	1.0758 "	1.0370 "	3.74
10.	0.9750 "	0.9423 "	3.47

The loss on ignition was thus considerably less than in Brauner's experiments. Although I made ten experiments I could not get more than 5.02 in any single experiment.

One may, perhaps, conclude that the reason for this difference is that the material used by Brauner contained samarium, but it cannot be so. In fact I am unable to suggest a satisfactory explanation. If the loss on ignition be considered peroxide-oxygen, my experiments tend to the formula DiO_2 , which requires 4.82 parts of oxygen to 100 Di_2O_3 .

Still, I am very much inclined to doubt that the loss by ignition is due to oxygen in chemical combination. I have tried to determine the oxygen by dissolving the peroxide in a mixture of sulphuric acid and ferrous-ammonia sulphate and titrating the unoxidised ferrous salt. Three different experiments gave for 100 Di_2O_3 only 0.74, 0.86, and 0.90 parts oxygen. This method is, I believe, very exact. I have used it to determine the oxygen in peroxide of hydrogen, and I obtained exactly the same result as that arrived at by determining the peroxide of hydrogen with permanganate of potash, which is a very exact method.

I conclude from my experiments that the loss by ignition of the peroxide is either occluded oxygen or is occasioned by the presence of small quantities of basic nitrate which have escaped decomposition. It is not possible to calculate a probable formula for the peroxide prepared on the dry way.

I then tried to obtain the peroxide by means of peroxide of hydrogen. The latter was obtained from M. Trommsdorff, in Erfurt, and was of great purity.

* Presented to the Royal Society of Sciences of Upsala, March 20, 1885.

† *Bihang till K. Sv. Vetensk. Akad. Handl.*, ii., No. 8.

‡ *K. Sv. Vet. Akad. Handl.*, xii., No. 4, 1874.

§ *Ofversigt af K. Sv. Vetensk. Akad. Förhandl.*, 1883, No. 2, p. 23.

|| *Berichte der Deut. Chem. Ges.*, vii., 798.

¶ *Liebig's Annalen*, cxc., 331.

* *Ofvers. af K. Sv. Vetensk. Ak. Förh.*, 1878, No. 5., p. 12.

† *Sitzber. d. k. Akad., d. Wissens. zu Wien.*, lxxxiv., p. 1179.

The cold solution of the nitrate of didymium was mixed with a much more than sufficient quantity of the peroxide of hydrogen and a solution of pure caustic potash added. A gelatinous precipitate, in all respects resembling the hydroxide of didymium, was thrown down; after a short time an abundant disengagement of oxygen commenced. The precipitate was rapidly and completely washed in darkness and at ordinary temperature, and immediately subjected to analysis. The material used for the experiments 1 to 4 was obtained in the above manner. For the experiments 5 to 6 the peroxide was prepared from sulphate of didymium. The oxygen was determined by mixing the peroxide with a known weight of ammonium ferrous sulphate and free sulphuric acid, the unoxidised ferrous sulphate being then determined by titration with permanganate. The didymium was afterwards precipitated with oxalic acid, and the oxalate ignited. The following results were obtained:—

No.	Di ₂ O ₃ .	Peroxide-oxygen.	Oxygen on 100 parts Di ₂ O ₃ .
1.	0.6472 grm.	0.0519 grm.	8.08
2.	0.4819 "	0.0390 "	8.10
3.	0.4984 "	0.0407 "	8.17
4.	0.4774 "	0.0381 "	7.98
5.	0.6202 "	0.0504 "	8.13
6.	0.5756 "	0.0476 "	8.27

The above six experiments give as a mean 8.12 parts oxygen for 100 parts Di₂O₃, approximating to the quantity required by the formula Di₄O₉, viz., 7.23 parts oxygen for 100 parts Di₂O₃. The formula Di₂O₅ requires 9.64. Some other experiments,* in which the peroxide was precipitated by ammonia, gave as a mean 7.28 parts oxygen for 100 parts Di₂O₃.

Chloride of Didymium, DiCl₃+6H₂O.

Large, violet, and easily soluble crystals, deliquescent in moist air.

0.8049 grm. gave 0.6415 grm. Di₂SO₄.

0.5980 " 0.7037 " AgCl.

In per cent—

		Calculated.	
Di..	..	39.57	142.0 39.83
Cl..	..	29.11	106.5 29.87
H ₂ O	..	(31.32)	108.0 30.30
			356.0 100.00

Specific gravity—

1.3308 grm., large crushed crystals, t° 15.8°, sp. gr. 2.287

1.4372 " " " " " 2.286

Molecular volume, 155.9.

Crystalline form asymmetric. The crystals are elongated parallel to oP:—

a : b : c = 1.37326 : 1 : 1.87177.

α = 89° 46' 4". β = 119° 44' 55". γ = 84° 57' 4".

Observed planes—

∞ P'; ∞' P; ∞ P ∞; ½ P; oP. (C. Morton.)

Oxychloride of Didymium, DiOCl.

If the oxide of didymium be heated in a current of chlorine it ignites, and gives a greyish powder consisting of the above oxychloride, which is very hygroscopic.

0.4422 grm. Di₂O₃ gave 0.5169 grm. DiOCl

2.2840 " " " 2.6661 "

According to these experiments 100 Di₂O₃ give 116.9 and 116.7 DiOCl; calculated, 116.6.

0.5169 grm. gave 0.3827 grm. AgCl and 0.4380 grm. Di₂O₃.

In per cent—

		Calculated.	
Di..	..	72.48	142.0 73.38
Cl..	..	18.31	35.0 18.35
O..	..	9.21	16.0 8.27
		100.00	193.5 100.00

* Bull. Soc. Chim., xliii., p. 56.

Specific gravity—

0.5827 grm., temp. 21.5°, sp. gr. 5.793

0.8295 " 21.2° " 5.735

0.7117 " 21.2° " 5.725

Mean of the three determinations, 5.751.

Molecular volume, 33.6.

Bromide of Didymium, DiBr₃+6H₂O.

On evaporating the solution of the oxide of didymium in hydrobromic acid over oil of vitriol, large and beautiful, but very deliquescent, tabular crystals are deposited.

0.7281 grm. gave 0.8349 grm. AgBr and 0.2444 grm. Di₂O₃.

In per cent—

		Calculated.	
Di..	..	28.71	142 28.98
Br .	..	48.79	240 48.98
H ₂ O	..	(22.50)	108 22.04
		100.00	490 100.00

Specific gravity—

0.6557 grm., large crushed crystals, temp. 20.7°, sp. gr. 2.803

0.7245 " " " " " 2.817

Mean of both determinations, 2.810.

Molecular volume, 174.4.

Bromide of Didymium with Bromide of Zinc, Di₂Br₃+3ZnBr₂+12H₂O.

According to Frerichs and Smith, the bromide of didymium gives with the bromide of zinc a very deliquescent double salt, crystallising in radiated needles, having the composition 2DiBr₃+3ZnBr₂+36H₂O. These authors say that the salt loses all its water (31.63 per cent) at 150°, and that the anhydrous salt thus obtained gave on analysis nearly all the calculated quantity of bromine. This is very remarkable, as hydrobromic acid may be evolved at the same time as the water, and it is scarcely probable that all the water could be lost at 150°. I have tried to get the salt described by Frerichs and Smith, but I obtained by slow evaporating of the solutions of the mixed bromides over oil of vitriol, large, well-formed, and rhombic tablets so extremely deliquescent that they could scarcely be freed from the thick mother-liquor. The salts obtained from two different crystallisations were analysed.

I. 1.0149 grm. was mixed with acetate of sodium, and the zinc precipitated with H₂S. The precipitate was dissolved and precipitated with Na₂CO₃. The didymium was precipitated with ammonia, and the solution of the hydroxide in nitric acid precipitated with oxalic acid. 0.1917 grm. ZnO and 0.1402 grm. Di₂O₃ were thus obtained.

II. 0.7615 grm. was precipitated with nitrate of silver, and the filtrate, after separation of the excess of silver, treated as in analysis I. 1.0039 grms. AgBr, 0.1440 grm. ZnO, and 0.1037 grm. Di₂O₃ were obtained.

In per cent—

		I.	II.	Calculated.	
Di ..	..	11.82	11.65	142	11.15
Zn ..	..	15.15	15.17	195	15.32
Br ..	..	—	56.10	720	56.56
H ₂ O	..	—	(17.08)	216	16.97
				1273	100.00

Chloroaurate of Didymium, DiCl₃+AuCl₃+10H₂O.

On slowly evaporating, over oil of vitriol, the mixed solutions of the simple salts, beautiful, large, yellow, rhombic, and very deliquescent tabular crystals are deposited.

0.7210 grm. gave with sulphurous acid and by evaporation 0.4755 grm. Au+Di₂SO₄, which, when treated with water, left 0.1933 grm. Au. The difference is 0.2822 grm. Di₂SO₄.

In per cent—

				Calculated.	
Di..	..	19'43		142	19'43
Au.	..	26'81		196	26'87
Cl..	..	—		213	—
H ₂ O	..	—		180	—
				—	—
				731	
Di ₂₃ SO ₄ +Au	65'95			—	65'94

Specific gravity—

0'8854 grm., large crushed crystals, t° 18, sp. gr. 2'662
0'7580 " " " " " 2'664
Mean of both determinations, 2'663.
Molecular volume, 274'5.

Bromoaurate of Didymium, DiBr₃+AuBr₃+10H₂O.

Large, dark-brown or almost black, shining, thick rhombic tablets, which are not very deliquescent.

1'3262 grms. were mixed with a solution of sulphurous acid and evaporated. The mixture of Au+Di₂₃SO₄ weighed 0'6469 grm. On dissolving in water 0'2615 grm. Au remained. The difference, or Di₂₃SO₄, is 0'3854.

0'6325 grm. was reduced with zinc and sulphuric acid. The remaining Au, washed with H₂SO₄, weighed 0'1241 grm. From the solution 0'7139 grm. AgBr was precipitated.

In per cent—

				Calculated.	
Di..	..	14'43	—	142	14'23
Au..	..	19'72	19'62	196	19'64
Br..	..	—	48'03	480	48'10
H ₂ O.	..	—	—	180	—
				—	—
				998	
Au+Di ₂₃ SO ₄	48'78	—		—	48'30

Specific gravity—

1'3292 grm., large crushed crystals, temp. 21'2°, sp. gr. 3'297
1'4832 " " " " " 3'311
Mean of both determinations, 3'304.
Molecular volume, 302'1.

Chloroplatinate of Didymium, DiCl₃+PtCl₄+10½H₂O.

This double salt crystallises from a very concentrated solution in deliquescent, orange-coloured, four-sided prisms.

0'4653 grm. was heated with oxalate of ammonia, and gave 0'2177 grm. Di₂O₃+Pt. After treating with sulphuric acid, 0'2907 grm. Di₂₃SO₄+Pt was obtained. 0'1176 grm. Pt being left after extraction with water, the mixtures contained, therefore, 0'1001 grm. Di₂O₃ and 0'1731 grm. Di₂₃SO₄.

In per cent—

				Calculated.	
Di..	..	18'40	18'47	142'0	18'33
Pt..	..	25'27		195'0	25'18
Cl..	..	—		248'5	—
H ₂ O	..	—		189'0	—
				—	—
				774'5	
Di ₂ O ₃ +Pt	46'79			—	46'61
Di ₂₃ SO ₄ +Pt	62'48			—	62'10

Specific gravity—

0'7094 grm., small prisms, t° 21'2°, sp. gr. 2'683
1'0993 " large crushed prisms, " " 2'696
Mean of both determinations, 2'689.
Molecular volume, 288.

Nitrate of Didymium, Di₃NO₃+6H₂O.

It was obtained, by slow evaporation over oil of vitriol, as a mass of flat prisms, which were not very deliquescent. 0'7997 grm. left by ignition 0'3959 grm. Di₂O₃.

In per cent.

				Calculated.	
Di ₂ O ₃	..	..	38'25	166	38'07
N ₂ O ₅	..	..	—	162	—
H ₂ O	..	..	—	108	—
				—	—
				436	

Specific gravity—

1'6799 grm., t° 19, sp. gr. 2'245.
1'6865 " " " " 2'253.

Mean of both determinations, 2'249.

Molecular volume, 193'9.

(To be continued).

ON THE INFUSION OF TEA.

By WILHELMINA M. GREEN.

THE chemical nature of tea, or rather of the tea-leaf, has frequently been made the subject of investigation, and, thanks to the labours of Peligot, Eder, Mulder, and others, we possess a considerable amount of information on the subject. Numerous determinations of the amount of the chief constituents of teas of different origin have been published during the last thirty years. We know, for instance, how the amounts of the theine, the tannin, and the leaf-juices vary with the age of the leaf and its mode of cultivation, manufacture, &c. But it is remarkable how little is known respecting the composition of tea-infusion as drunk, and of the conditions which determine the extraction of the various soluble constituents. Tea-infusion has been drunk in this country for upwards of three centuries, yet there seems to be little uniformity of opinion as to the best modes of preparing it. It may be assumed, therefore, that a careful examination of the conditions which affect the nature of the infusion would indicate the most rational method of its preparation.

It is generally agreed that the value of this infusion as a food, or as a stimulant, is related to the proportions of theine, tannin, and essential oil which it contains. Whether the inorganic constituents affect its alimentary value remains to be determined, but it is at least possible that the power of tea-infusion to aid in the digestion—or rather in the assimilation, according to Dr. E. Smith—of other foods may partly depend upon the potash compounds which the leaf contains in so remarkably large a proportion.

There remains, however, a large field for experimental work on the physiological effects of tea-infusion. The soluble constituents, are the theine, the tannin, the aromatic oil, the larger portion of the salts, and a very small amount of legumen; but this is soluble in such small quantity that it need not practically be considered. Of these the tannin is known as a powerful astringent: it has a certain medicinal value, but its harmfulness, if habitually taken in any quantity, is well understood. With regard to the theine and oil, however, there is great difference of opinion. Dr. Edward Smith's experiments in 1858 seemed to prove that they hastened respiration and elimination of carbonic acid, and therefore the conversion of carbonaceous food and the waste of tissue, and this he attributed to the active principle, theine. Drs. Bernays and Lankester, on the contrary, assert that the effect of theine is to *retard* the waste of tissue. According to Dr. Smith tea assists in assimilation, though not in digestion, and he considers it on this account a wholesome drink two or three hours after, but not with, a heavy meal, and for the same reason he recommends it as a drink for the robust and over-fed; but from its power of increasing the waste of tissue he considers it an unwholesome drink for the old and feeble, for children, and for the poor and under-fed. Even those who believe it to retard the waste of tissue discourage its use by the poor, as these allow it

to take the place of real food. Again, Dr. Smith speaks of theine as that constituent of tea which excites the nervous system, stimulates thought and imagination, and causes wakefulness; while others refer to its soothing effect on the nervous system, and state it to be a sedative.

Blyth quotes some experiments on the physiological effect of theine performed on themselves by Pratt and Schwann, from which it would seem that the effect varies with the quantity taken. 0.3 grain lowered the pulse and produced sleeplessness; 0.5 grain increased the pulse, excited the brain, but *finally* brought a desire for sleep; 0.8 grain caused uneasiness and anxiety, trembling, and finally dreaming and restless sleep. This looks as if theine might in small quantities act as an excitant, and in larger amounts—or after a longer time—as a sedative. But its effect appears to differ, not only with the quantity taken, but with the person who takes it; and the question evidently wants much more thorough investigation than it has yet received.

According to observations by Dr. Lettsom more than a hundred years ago, Pereira, and others, the aromatic oil, though only present in black tea in the proportion of three-quarters per cent, is the constituent which has such a powerful effect on the nerves. The Chinese are said to keep their tea for a year before using it, in order to get rid of the "intoxicating, or at least highly stimulating, properties, of the oil." One Chinese writer says that it "disorders the senses," while several English writers mention its virtues as a diuretic and diaphoretic agent. Apparently, then, it is either the oil or the theine which gives tea its stimulating and refreshing effect. The oil also gives it its peculiar taste. It is these constituents, therefore, which tea-drinkers wish to get. But the various soluble constituents are very differently soluble in water, and there is no doubt that the rates of their solution are affected to a great extent by the temperature of the water. I have accordingly made a series of observations in which time and temperature were the principal factors, with the view of throwing some light upon the points at issue. We require to know, for instance, whether the theine is more rapidly dissolved out than the tannin; what proportion of total nitrogen remains in the exhausted leaf; and whether the amount of soluble inorganic matter is much affected by the temperature and length of time.

Determinate weights of tea were therefore infused with definite volumes of boiling water for definite lengths of time, under conditions as nearly as possible resembling what may be taken to be, on the whole, the ordinary practice; and the amounts of theine, tannin, nitrogen, and ash in the several infusions were estimated; experiments being at the same time made on the partially exhausted leaves.

The tea which served for my experiments was an Assam Pekoe-Souchong. This is a leaf of medium age: those gathered very young are called Pekoe, and those gathered after all the flowers are faded make Souchong. This tea is of an age between the two. Its total amount of theine, tannin, nitrogen, and ash were found to be as follows:—

Theine	1.5 per cent
Tannin	21.46 "
Nitrogen	3.37 "
Ash	5.59 "
{ Soluble ash	4.31 "
{ Insoluble ash	1.28 "

I noticed some peculiarities in this tea.

(a.) The infusions became very turbid on cooling. It has been alleged that this turbidity probably arises from the gum dissolved out by the hot water, which solidifies on cooling. Whether this explanation be held to be satisfactory or not, it is to be noted that during the manufacture of the leaf in China every gum-cell is broken and the gum squeezed out; the manufacturers of India, on the contrary, leave it all in the leaf.

(b.) The total amount of matter soluble in water is larger than that of most teas. The average I found from four observations was 43.54 per cent, as compared with 41.3 in yellow and green teas, and 38.7 in black teas found by Eder.

(c.) The proportion of soluble ash is larger than that of other varieties of tea. Eder says that all varieties contain in mean about 5.67 per cent of ash, of which 2.77 is soluble. Wigner finds 5.78 per cent, 3.15 soluble. This Assam Pekoe-Souchong has more, as stated above.

(d.) The amount of tannin is very much larger than usual. Eder's and Mulder's averages were as follows:—

Eder.		
In black teas.. ..	10.09	per cent
In green teas	12.40	"

Mulder.		
In black teas.. ..	12.88	"
In green teas	17.80	"

(e.) There is not much more than half the nitrogen than Péligré found in other varieties, and even in Assam tea.

Péligré's determinations were:—

Pekoe	6.58	per cent
Gunpowder	6.15	"
Souchong	6.15	"
Assam	6.10	"

Before stating the results of the chief part of my work, I may mention two less important determinations made meanwhile:—

I. Extractive Matter by Water.

Total exhaustion (average of 4 determinations) 43.54 p.c.

Loss after 5 mins. infusion, 21.78 per cent

" 10 "	25.35	"
" 20 "	26.81	"
" 40 "	28.14	"

II. Amount of Water in Air-dried Tea.

The tea was dried at 100° till it had a constant weight. 5 grms. took about four hours to dry.

Average of three determinations, 7.76 per cent.

In imitating as nearly as possible the average conditions under which tea is made, I was of course obliged to make the one great difference of using distilled water, as ordinary drinking-water would vary in every district, and would affect the amount of ash, and of organic matter also, by its action on the legumen. For purely scientific purposes I might have made other differences as well, but keeping my aim in view the arrangements were as follows:—

I found the average teaspoonful weighed 3.4 grms. I considered three-quarters of a pint (420 c.m.) as the average amount drunk by each person, and on the time-honoured principle of "a teaspoonful for every person and one for the pot," I allowed a little more than 3.4 grms., i.e., 3.5 grms. to every 420 c.m. of water. I used a white earthenware teapot, and it was always heated by hot water before being used. The measured volume of the water required for the infusion was so heated that there was no appreciable loss by evaporation. The moment the water reached 100° C. it was poured on to the tea, and the teapot immediately covered with a cosy, and when it had stood for the requisite time the infusion was poured off through a strainer. I found that when it was poured off after standing 40 mins. the temperature of the water had fallen to about 60° C.

It was curious to notice, when measuring the infusions poured off the leaves, how much the amount of water absorbed by the leaves varied. The amount was generally about 3 per cent, but it varied from that to 5 per cent.

Methods.

Ash.—I used the *infusions* for evaporating to dryness and incinerating,—not the partially spent leaves, except to find the *total* soluble and insoluble ash, when ash left from incineration of totally exhausted leaves was subtracted from total ash in air-dried leaves.

Nitrogen.—About 1 grm. was used for each determination, and the leaves were completely dried and powdered before weighing. The results, however, were calculated so as to give the percentage in air-dried leaves. After combustion with soda-lime the ammonia was combined with platinum tetrachloride, and the double salt reduced to platinum. As the infusions could not be used for these determinations, the results were obtained by subtracting the amount of nitrogen left in the partially exhausted leaves from the total amount.

Tannin.—The determinations of tannin were made according to Eder's method,* by the addition of copper acetate to the infusion. The copper tannate formed is incinerated with flowers of sulphur in a stream of hydrogen, and thus changed to cuprous sulphide: 1 grm. $\text{Cu}_2\text{S} = 1.3061$ gr. tannin.

To find the total tannin the filtrate from exhausted leaves was used, and for the rest of course the infusions of different durations. Sometimes the leaves left from an infusion were exhausted and the tannin in them determined, the result being used as a check by subtracting the amount from the total.

About 2 grms. of leaves were used for each determination, and for total exhaustion they were boiled three times successively for 45 mins. in 100 c.c. water, the filtrates being united at the end. The filtrate was in all cases, except that of the 40 mins. infusion, raised almost to boiling-point before adding the copper acetate, in order to re-dissolve any precipitated tannate of theine: the 40 mins. infusion was only raised to a temperature a few degrees higher than that to which it had fallen while standing under the cosy (see *ante*).

The strength of the acetate solution was 1 : 20, and 25 c.c. of the solution were used for each determination. A flocculent brown precipitate of copper tannate was formed, and the liquid was left standing a few days before being filtered. The filtrate was bright grass green. The precipitate was dried on the filter, then washed with hot water till it gave no colouration with potassium ferrocyanide, and dried again. It was then heated to redness in a weighed porcelain crucible, mixed with flowers of sulphur, and heated in hydrogen, as above stated.

Theine.—This was determined by Mulder's method modified by Patrouillard. I took 5 grms. of tea for each determination of total theine, exhausted it, and evaporated the infusion to dryness, adding, when it had reached a syrupy consistence, 1 grm. of calcined magnesia (to set the theine free by combining with the tannic acid), and 2 grs. sand. The residue was further dried in the water-bath, and then, while still hot, very finely powdered with a heated pestle. The powdered residue was then put into a flask, ether was added, and it was left to stand, with occasional agitation, for several days; the ether was then decanted and distilled off, the operation being repeated four times, and the total amount of ether used being 300 c.c. To the residue I added chloroform, when the greater part of it was re-dissolved. The solution was filtered into a weighed flask, the chloroform distilled off, and the flask dried for a few minutes in the water-bath, and weighed again. The method of determining the theine in the infusions of various durations only differed from the above in that the first 5 mins. and the third 20 mins. determinations were made by exhausting the leaves after pouring off the infusions, and subtracting the results from the average total. The rest of the determinations were made from the infusions themselves, 4 or 5 grms. having been infused, and half the infusion taken. The chloroform was left on the residue from the ether for four hours.

RESULTS.

Ash.

	No. of determinations.	Average results.
5 mins. ..	2	3.52 per cent
10 „ ..	4	4.09 „
20 „ ..	2	4.15 „
40 „ ..	3	4.48 „
Total ..	3	5.59 „

Nitrogen.

	No. of determinations.	Average results.
5 mins. ..	2	1.11 per cent
10 „ ..	2	1.16 „
20 „ ..	2	1.11 „
40 „ ..	2	1.04 „
Total ..	5	3.37 „

The slight reduction in soluble nitrogen is possibly due to the re-precipitation of the soluble nitrogenous bodies during the gradual cooling of the 20 mins. and 40 mins. infusions. That there must be other soluble nitrogenous bodies besides the theine is shown by the fact that the percentages of soluble nitrogen are about the same as those of the theine, whereas the total nitrogen in theine only amounts to one-sixth of that body, or 0.25 per cent of the tea. The *total* nitrogen is in part made by the large amount in the legumen, but as legumen is so slightly soluble in water this does not account for the nitrogen in the infusions.

Tannin.

	No. of determinations.	Average results.
5 mins. ..	2	6.85 per cent
10 „ ..	2	8.52 „
20 „ ..	2	11.73 „
40 „ ..	1	16.32 „
Total ..	5	21.46 „

Theine.

	No. of determinations.	Average results.
5 mins. ..	2	1.11 per cent
10 „ ..	2	1.30 „
20 „ ..	2	1.16* „
40 „ ..	—	—
Total ..	3	1.5 „

From the above results, and from the fact that the aromatic oil is soon dissolved out in hot water, it would seem that the best tasting, and on the whole most wholesome, infusion of tea is made by pouring boiling water on the leaves, allowing it to stand on them for seven or eight minutes, and then pouring off the infusion. The amount of water required should all be put on at once; the old-fashioned plan of “drawing” the tea and then diluting is irrational; but by the above method we get the oil, nearly all the theine, more than half the ash, and only about one-third of the astringent and bitterly-tasting tannin.

Dr. Smith observes that the longer tea is brewed, the more strongly it acts in preventing sleep, and attributes this to the increased quantity of theine brought out. Now as I have found that the theine is practically all dissolved out in the first ten minutes, but that the amount of tannin very much increases afterwards, is it not possible that the effect noticed by Dr. Smith is caused by the power of tannin to coagulate albumen, and form insoluble compounds with gelatin and other nitrogenous substances? Schwann found that in *artificial* digestive fluids tannin was precipitated, and rendered them inert.

* See Paper by Eder on the “Valuation and Properties of China Tea” (*Dingl. Poly. Journ.*, 1878, 229, 81; 1879, 231, 445).

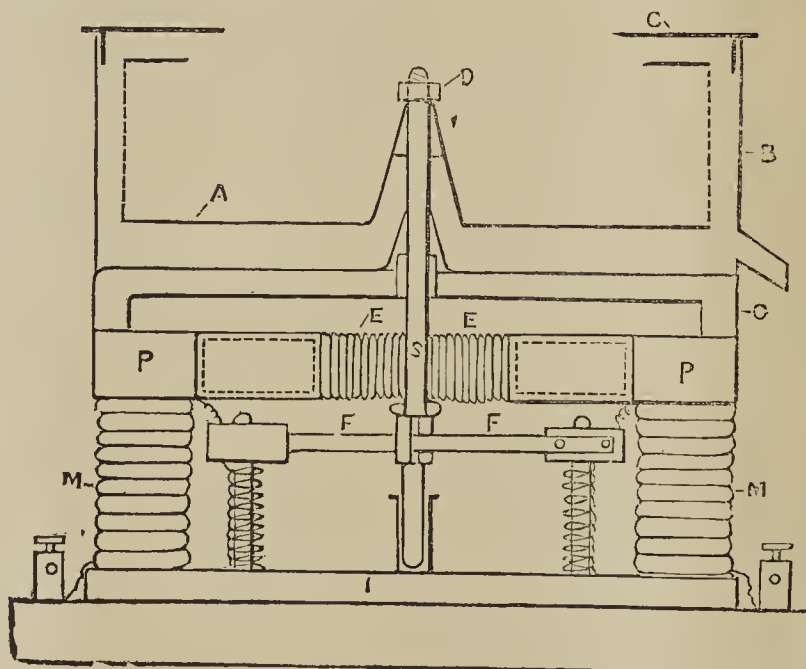
* Possibly this lower percentage may be owing to the precipitation of theine as the tannate, which is but sparingly soluble in cold water

AN ELECTRICAL CENTRIFUGAL MACHINE
FOR LABORATORIES.*

By ALEXANDER WATT, F.I.C., F.C.S.

THE late Dr. Mohr,† of Bonn, advocated the use of a centrifugal machine as a means of rapidly drying crystals and crystalline precipitates, but although they are admirably adapted for that purpose, centrifugal machines are seldom seen in our chemical laboratories.

The neglect of this valuable addition to our laboratory apparatus is probably owing to the inconvenience involved in driving the machine at a high speed by means of the ordinary hand driving gear, especially when the rotation has to be maintained for a considerable length of time. It occurred to me therefore, that by attaching the drum or basket of the machine (or the rotating table of Mohr's apparatus) directly to the spindle of an electro-motor the difficulty of driving might be got over, and at the same time a combination of great efficiency would result, as the electro-motor, like the centrifugal machine, is most efficient when run at a high speed. The apparatus shown in the sketch consists essentially of a perforated basket, A, which is slipped on to a cone attached to the spindle, S, of an electro-motor, and held in position by the nut, D.



The casing, B, with its removable cover, C, serves to receive the liquid driven out of the substance being dried. A flat form of the ordinary Siemens H armature, E, revolves between the poles, P, of the electro-magnets, M, which are connected by means of the base plate, I. The brass cross-bar, G, carries the top bearing of the spindle, S, and prevents the magnet poles from being drawn together.

From four to six cells of a bichromate battery or Faure secondary battery furnish sufficient power to run the machine at a high speed. An apparatus with a copper basket 4 inches in diameter has been found extremely useful in the laboratory for drying such substances as granulated sulphate of copper and sulphate of iron and ammonia, but more especially for drying sugar, which, when crystallised in very small crystals cannot be readily separated from the syrupy mother-liquor by any of the usual laboratory appliances. For drying substances which act on copper the basket may be made of platinum or

ebonite; in the latter case, owing to the increased size of the perforations, it may be necessary to line the basket with platinum wire gauze or perforated parchment paper.

PHYSICAL MOLECULAR EQUIVALENTS.*

By Professor GUTHRIE, F.R.S.

INVITED to contribute to the discussion on molecular weights, my best plan will be, I think, to describe in what way some of my own investigations may serve to throw light on the matter.

These investigations have all been published in the *Philosophical Magazine* and in the *Proceedings of the Physical Society*, and the paragraphs are identically numbered in both, from § 1 to § 255.

When I first observed that a salt soluble in water might, and did, form a solid hydrate with ice at a temperature below 0° C., I was under the impression that such compounds were built up in the same fashion as ordinary hydrates or other compounds, namely, *n*-molecules for *m*-molecules. Thus, I conceived the cryohydrate of sodium chloride to be $\text{NaCl} + 10\text{H}_2\text{O}$. (§ 14.) But when a greater

number of salts were examined this notion had to be abandoned. It was found, for instance, that potassium sulphate combined with ice in a ratio represented by $\text{K}_2\text{SO}_4 + 114\cdot2\text{H}_2\text{O}$, while each molecule of potassium nitrate demanded 44·6 molecules of water. (§ 88, Table.) These mass ratios are not to be aligned with the mass ratios of ordinary chemical compounds.

At the same time the existence of another class of hydrates brought itself forward, namely, the sub-cryohydrates. These are truly molecular hydrates, and though of comparatively rare occurrence among metallic inorganic salts (§ 146, § 181), are of the utmost interest in organic compounds, and especially amongst liquids.

It is by the study of these bodies that perhaps much light will be thrown upon the molecular mass ratio of liquids; for although requiring a temperature below zero for their existence as solids, they are quite continuous in their formation and properties with ordinary crystalline hydrates. Thus, the sub-cryohydrate of diethylamine is a perfectly crystalline solid body, melting at -9·1, and con-

* Paper read before Section B, British Association, Aberdeen Meeting.

† "Lehrb. d. Chem. Analyt. Titrimethode," 3rd Ed., 1870, p. 684.

* A Paper read before Section B, British Association, Aberdeen Meeting.

taining 27 molecules of water to 1 of the anhydrous base. (§ 236.)

It is, further, clear that the definite mass ratio of the cryohydrates beyond, or apart from, atomic or molecular weight, but yet as definite and constant as any mass ratio resulting from such molecular weight, presents itself in the formation and properties of metallic alloys. These bodies, when in the ratio which ensures the lowest temperature of liquefaction, are never in atomic ratio. (§ 195 to § 205). They are perfect homologues of the cryohydrates. Again, metals do unite with one another in atomic weight ratio, but the resulting alloy is never then eutectic, that is, having a minimum solidifying-point. Pure cast-iron, that is, iron with carbon only, is not a carbide of iron, but an eutectic alloy of carbon and iron.

We find, again, that this hyper-chemical mass ratio obtains amongst salts without water: when one salt fused, *per se*, acts as a solvent to another salt. (§ 210 to § 229.) Eutectic salt-alloys are formed homologous with the cryohydrates and with the eutectic metallic alloys. The mineral world affords an endless series of the latter class.

But although, perhaps, experiments such as my own, and cases such as I have adduced, form the most striking instances of two masses of unlike matter dealing critically with one another when not in any integral ratio of their molecular masses, yet we need not go so far afield. At 14° C. 1 grm. of water is required to deal critically with (fully to dissolve) 0.25 grm. of nitre. At 100° C. it deals critically with 2.51 grms. At 300° it deals critically with 98.86 grms. At 320° it deals critically with an infinite weight. In other words, the nitre fuses *per se* at this temperature. (§ 252.) This and similar cases may be due to the circumstance that while at a given temperature the *vis viva* of each nitre molecule may be the same as that of each water molecule, their velocities are different, and when the whole receives an equal increment of temperature, the relative velocities of the two systems of molecules changes.

Another instance of definite molar mass ratio apparently unconnected with molecular mass ratio is presented to us by the thickness of liquid slabs. At a given temperature and with a constant *g*, a horizontal air-supported slab of mercury has a constant thickness. A slab of water has another thickness. A vertical prism of the one of a certain section has a constant ratio to a similar prism of the other.

Liquids, which one would scarcely suspect of having any relationship either chemical or physical with one another, are yet found, perhaps, without exception, either to get warm and finally lose volume, or get cool and finally gain volume. The former points to chemical union, the latter to—what? Thus it seems certain (§ 268) that chloroform unites chemically with alcohol, ether, and amylene; that benzol unites with ether, forming bodies analogous with the sub-cryohydrates, and having their prototype in the sub-cryohydrate of alcohol, $C_2H_6O_4H_2O$. (§ 274.) But if we examine the mixtures where expansion and cooling ensues, we find that the maximum of these effects, which are the antitheses of chemical effects, takes place at a certain simple molecular weight ratio. This, which we may call the ratio of maximum molecular repulsion, in the case of carbon bisulphide and chloroform is the molecular ratio of 1:1. In the case of carbon bisulphide and alcohol 2:1. (§ 264 to 271.)

Still more noteworthy is the fact that mixtures in these ratios show abnormally high vapour-tensions. (§ 272 to 279.) I may add in this direction that certain unpublished experiments of my own convince me that when carbonic acid and hydrogen are mixed the joint volume is measurably greater than the sum.

Adulteration of Phenol-phthaleine.—P. Guyot found a sample of this reagent adulterated with powdered turmeric. In other samples he has found sodium sulphate in proportions of from 16 to 21 per cent.—*Journ. de Pharm.*, No. 6.

TREATMENT AND QUALITATIVE COMPOSITION OF ZIRCON.

By ED. LINNEMANN.

A PRACTICAL question, the reply to which is also of pure scientific interest, induced me to work up large quantities of zircons for zirconia. The observations which I had thus the opportunity of making seemed to me worth communicating, and are given below.

Zircon belongs to the hardest silicates and those most difficult of solution. To facilitate the pulverisation of zircon, which prior to solution must be converted into a very fine powder, it is usually heated to redness and thrown into cold water. The zircon then becomes dull in consequence of the production of a multitude of cracks, and can be somewhat more readily pulverised.

This object can be attained much more readily by exposing zircon-crystals to the action of the vapours of hydrofluoric acid. They crumble then to a coarse powder, which can be readily pulverised in an iron mortar. Zircon crystals from the Ural and from North Carolina behaved in this respect exactly alike. All crystals, however, do not crumble to an equal extent. Many of them yield completely, but in others the better developed end-surfaces remain in cohesion, but still fall readily to powder under the pressure of the pestle.

The zircon-crystals from the sources above named are provided with innumerable fine clefts, filled up with a silicate which is easily and completely dissolved by gaseous hydrofluoric acid, whilst the fundamental crystalline mass remains unattacked.

We have thus a means of obtaining the fundamental crystalline mass of zircon-crystals in a state of perfect purity.

The method of thus preparing zircon for solution may be seen from the following examples:—

193 grms. of entire crystals from North Carolina, placed in a platinum crucible, were exposed for ten days to the vapour of hydrofluoric acid, turning them frequently; the crumbled mass, with the addition of water, was heated for some time on the water-bath, and was perfectly washed, finally with an addition of hydrochloric acid. The washed zircon powder, which after being strongly dried weighed 187 grms., was easily crushed in an iron mortar to a powder fine enough to pass through the finest silk sieve. By treatment with aqua-regia the iron derived from the mortar was removed, and the zircon thus prepared, after washing and strongly drying, appeared as a heavy snow-white powder, resembling pipe-clay; neither hydrofluoric acid nor aqua-regia extracted any appreciable quantities of mineral substance. Its weight was 180 grms., or about 93 per cent of the original crystals.

Hence the above-mentioned crystals of North Carolina zircon contain about 4 per cent of a silicate soluble in aqua-regia, and containing the following metallic elements:—Sodium, potassium, lithium, magnesium, calcium, aluminium, iron, and zirconium.

Zircon from the Urals, consisting of large, single, but badly developed crystals, approximating to the garnet type, gave the following result on similar treatment:—They contained about 5 per cent of a silicate attacked by hydrofluoric acid, and containing the same metallic elements as that of North Carolina with the exception of lithium. It yielded 94 per cent of finely-powdered zircon ready for being opened up.

The opening up of zircon according to the methods hitherto recommended is a difficult matter, and on the large scale impossible. Of the fluxes proposed—caustic soda, sodium carbonate, sodium bisulphate, and sodium fluoride—the last-mentioned attacks zircon most readily, but it is from other reasons inapplicable on the large scale. The other fluxes attack zircon too slowly and imperfectly; the mixture must be heated for hours to the highest attainable temperatures: the quantity of zircon rendered soluble is still too trifling, and the injuries to the

crucibles are so great that, all things being considered, these methods cannot be used on the large scale.

After numerous and tedious experiments I succeeded in finding a method which admits of opening up 25 grms. of zircon in fifteen minutes with a simple Bunsen burner,—a method which in other cases has been found signally successful for unlocking silicates, and which will be a useful acquisition for the laboratory.

The flux consists of a mixture of caustic soda with a little sodium fluoride. Such a mixture attacks finely-powdered zircon more quickly and readily than sodium fluoride alone.

There are formed at first sodium silico-fluoride and metallic fluorides, which are converted by the melting caustic soda into sodium silicate and metallic oxides, the mass swells up, watery vapour is liberated, and the sodium fluoride is constantly regenerated, whence a small quantity of it is quite sufficient. With the cessation of the formation of water, *i.e.*, the swelling up of the melt, the reaction is at an end, and the silicate is rendered soluble.

This operation was effected in a heavy silver crucible, containing about 200 c.c., weighing with its lid 250 grms., and having a diameter at top of 75 m.m., a height of 70 m.m., whilst its sides were 2 m.m. in thickness.

One hundred grms. of caustic soda, previously melted until it flows quietly, 10 grms. sodium fluoride, and 25 grms. of prepared zircon, previously passed through a fine silk sieve, are put into the crucible, which is heated over a good Bunsen. With a full pressure of gas the frothing up begins quickly, and with attention, regulating the burner, and occasionally removing it, an overflow is easily avoided. In ten to fifteen minutes the main reaction is over, and gas-bubbles escape from the quietly flowing mass without foaming. This succeeding reaction is due to the circumstance that any rather coarser particles of zircon require a longer time to be dissolved by the flux. To attain this end as perfectly as possible the crucible is covered with its lid, and the heat is continued at dark redness for half an hour.

It is advisable to stir from time to time with a stout platinum wire. Even at the end of this time the liquid is still thin and mobile. It is poured out into a silver dish in thin cakes, which are easily detached on cooling. When treated with hot water they are resolved into zirconia-soda and the accompanying metallic oxides, whilst soda, sodium silicate, and sodium fluoride dissolve. In this alkaline solution none of the oxides derived from the zircon could be detected, save alumina and lithia.

On dissolving the crude zirconia-soda in hydrochloric acid some undissolved zircon remained behind along with silica, and after the latter had been removed by means of soda-lye it amounted, as a mean of several experiments, to 1.5 of the prepared zircon operated upon.

The portion of the melt insoluble in water, crude zircon-soda, is washed as completely as possible by decantation, ceasing as soon as the deposit no longer settles easily, which always happens as soon as the saline matter of the washings falls below a certain point. The solid matter is collected on filters, and dried first in the air and then on the water-bath.

Twenty-five grms. of prepared zircon yield in this manner, as the average of seven experiments, 26 grms. of crude zirconia-soda, the product ranging in the extreme cases from 23.5 to 30 grms.

For the further treatment of the crude "zirconia-soda" it is dissolved in excess of dilute hydrochloric acid, repeatedly evaporated to dryness, as for the separation of silica. By this means not merely silica is eliminated, but hydrofluoric acid escapes, and a very small quantity of undissolved zircon is removed.

The separation of zirconium chloride from all the other metallic chlorides obtained from zircon is effected very simply, by treatment with a mixture of hydrochloric acid at sp. gr. 1.17, absolute alcohol, and ether, in which $ZrCl_4$ is quite insoluble, whilst all the other chlorides are soluble down to very minute traces.

The impure $ZrCl_4$, containing especially sodium chloride, is to this end thoroughly dried on the water-bath, reduced to the finest powder, and rubbed through a fine sieve. The powder, fine as dust, is put into a capacious flask, and mixed with such a quantity of pure hydrochloric acid that the mass, even after standing for several days, remains liquid on inverting the flask, and does not thicken or solidify. The volume of the hydrochloric acid which has been used is noted, and three times the volume of absolute alcohol is gradually added with agitation. Much heat is evolved and much $ZrCl_4$ is dissolved, which, however, separates out again almost entirely on cooling, and the subsequent dilution of the mass with pure ether. This addition of pure anhydrous ether must be effected gradually, and with agitation, until 10 vols. of ether have been added to 1 vol. hydrochloric acid. After standing for some hours the $ZrCl_4$ is removed from the filter, and stirred up with a mixture of 1 vol. pure concentrated hydrochloric acid, 3 vols. absolute alcohol, and 40 vols. of pure ether, filtered, and washed, first with this mixture and then with pure ether, until it runs off no longer yellow, but colourless.

By repeating this operation the $ZrCl_4$ can be obtained absolutely free from iron. Such a repetition is not recommended when working with larger quantities, as the further precipitation of the $ZrCl_4$ can be effected in another manner.

After this treatment the sodiferous zirconium chloride is dissolved in water, separated from a little silver chloride (from the crucible), mixed with some sodium acetate, and thoroughly precipitated with sulphuretted hydrogen; the slight precipitate of copper, bismuth, and tin is removed, the liquid heated until the sulphuretted hydrogen is expelled, mixed with sal-ammoniac, and precipitated with ammonia. The hydrated zirconia is washed until the reaction of chlorine disappears, twice re-dissolved in hydrochloric acid, precipitated with ammonia; finally dried on the water-bath, finely powdered and sifted.

I will designate it as "crude hydrated zirconia." The washing waters which pass off in this operation contain, along with soda, lime and magnesia.

The weight of the "crude hydrated zirconia" thus obtained from 400 grms. "crude zirconia-soda," or from about the same weight of zircon-crystals, is 283.5 grms. It yielded 77 to 78 per cent of residue on ignition, whilst pure $Zr(OH)_4$ on conversion into ZrO_2 should yield 77.1 per cent of an ignited residue. A small quantity of this "crude hydrated zirconia" dissolved in hydrochloric acid, twice precipitated with ammonia, converted into chloride, and repeatedly treated with the above-mentioned mixture of hydrochloric acid, alcohol, and ether, yielded $ZrCl_4$ perfectly free from iron,—a fine crystalline, snow-white, silky powder, which left on ignition 50 per cent of residue, whilst pure $ZrCl_4$ should leave 52.5 per cent of residue. Hence we see that the above-mentioned mixture of hydrochloric acid, alcohol, and ether, throws down zirconium chloride chiefly as a neutral, and not as a basic compound.

"Crude hydrated zirconia" retains small quantities of iron, zinc, copper, magnesium, lead, calcium, and sodium. But on account of the minute quantity of these impurities their removal is not easy. Zirconia precipitated as an amorphous compound, as hydroxide, basic sulphate, basic chloride, or basic acetate, always carries down with it a portion of these impurities, and a repetition of this operation does not answer the purpose.

The precipitation of zirconia by potassium sulphate at a boiling-heat has been recommended as a means of purification; but in this manner it is not even possible, on repeating the precipitation, to obtain zirconium sulphate free from iron.

By this opportunity I have made an observation not yet recorded, that the precipitate is almost absolutely insoluble in a saturated solution of potassium sulphate, but not in water. On continued washing a considerable quantity dissolves in proportion as the potassium sulphate

is removed, whilst the rest of the sulphate remains quite insoluble. It appeared that the original precipitate comprised two distinct zirconium sulphates,—the one insoluble in potassium sulphate, but not in water; the other insoluble in both. The soluble salt, as well as the insoluble, behaved quite alike on a repetition of the experiment, both—like the original solution of zirconia—furnishing anew each a soluble and an insoluble basic sulphate. The earth contained in both salts showed no difference, and consisted of the same zirconia.

(To be continued).

REPORT ON ASH OF WOOD AND OTHER FOREST PRODUCTS.

By R. ROMANIS,
Chemical Examiner, British Burma.

IN analysing the specimens of wood, I have separated the heart-wood from the sap-wood, and the result shows that the composition is very different. As a rule, phosphoric acid and potash are found in largest proportion in the sap-wood, and lime in the heart-wood. The bark resembles the heart-wood in composition, as will be seen on comparing shaw-wa and shaw-ni with any of the heart-woods.

The composition of teak ash, both of sap and heart-wood, is very peculiar and altogether different from that of any other wood. It is principally composed of phosphoric and silicic acids and magnesia in nearly equal proportions. With these we have in the sap-wood about 13 per cent of potash, which is replaced by 12 per cent of lime in the sap-wood. This peculiarity of composition may explain the failure of teak in some situations. It has been

suggested that the hardness of teak may be due to the phosphates and silicates contained in it, but pyingado or iron-wood (*Xylia dolabriformis*), which is even harder than teak, does not differ from other kinds of wood in the composition of its ash, of which it contains only 0.3 per cent.

Bark contains the largest proportion of ash, the sap-wood next, and the heart-wood least. But in many cases it was impossible to say where the sap-wood ended and the heart began.

The trees which grow in the delta of the Irrawaddy, as ma-u (*Sarcocephalus*) and letpan (*Bombyx*), contain more magnesia than lime. The soil in that part is deficient in lime; magnesia would seem to replace it in the tissues of the plant.

I may note that an analysis of teak (published in *Landw. Versach.*, St. xxii., 68; xxiii., 413) quoted in "Watts's Chemical Dictionary," gives lime and magnesia in reversed proportions to those found by me.

In order that these analyses should be of value for purposes of forestry, they should be supplemented by analyses of the soils of the country.

AN ELECTRICAL FURNACE FOR REDUCING REFRACTORY ORES.*

By T. STERRY HUNT, LL.D., F.R.S.

THE accompanying notice of the new electrical furnace and its results, which was read before the American Institute of Mining Engineers at Halifax, Nova Scotia, on September 17th last, may be of interest. To the chemist the possibilities opened by this new device are very great,

Analysis of the Ash of certain Burma Timbers and other Forest Products.

(These numbers express the composition of the ash after deducting carbonic acid and charcoal).

	Teak (<i>Tectona grandis</i>).	Cutch (<i>Acacia catechu</i>).	Pyingado (<i>Xylia dolabriformis</i>).	Ma-u (<i>Sarcocephalus cadamba</i>).	Mango (<i>Mangifera Indica</i>).	Letpan (<i>Bombax malabaricum</i>).	Mvauchaw (<i>Homalium tomentosum</i>).	Thingan (<i>Hopea odorata</i>).	Thitka (<i>Pentace Burmanica</i>).	Shaw-wa (<i>Sterculia ornata</i>).	Shawbyu (<i>Sterculia versicola</i>).	Shaw-ni (<i>Sterculia villosa</i>).	Myinwa bamboo (<i>Bambusa</i>).	Thingan bark (the bark of the <i>Hopea odorata</i>).
<i>Sap-wood.</i>														
Potash	12.75	27.44	29.81	43.42	26.98	52.90	39.22	45.62	32.60	16.43	25.83	20.54	12.83	9.72
Soda	2.58	11.42	1.99	0.74	2.72	0.12	0.36	0.94	0.25	1.41	0.52	2.62	1.10	—
Lime	7.35	30.71	30.45	2.37	44.80	8.00	38.56	24.39	6.71	57.02	33.47	57.08	1.68	64.9
Magnesia ..	30.57	18.26	7.66	23.35	11.80	20.10	3.40	12.62	21.63	15.37	20.31	9.67	2.26	5.5
Ox. of magnesia	—	0.23	trace	—	—	—	—	—	0.71	—	0.60	—	0.16	—
Oxide of iron ..	2.42	2.41	3.44	1.34	0.64	2.44	2.39	2.61	5.45	1.33	1.94	1.53	0.18	—
Phosphoric acid	30.97	6.26	22.60	18.65	12.28	13.21	13.10	8.91	26.22	2.30	3.74	1.72	7.29	—
Sulphuric acid	trace	3.54	1.22	9.13	1.78	1.63	1.85	1.71	1.71	0.33	0.23	0.90	0.75	—
Silicic acid ..	23.36	trace	2.73	1.00	—	2.50	0.78	3.20	4.68	6.27	13.53	3.57	73.73	—
Chlorine	—	0.77	—	—	—	—	—	—	—	—	—	3.02	—	—
	100	100	100	100	100	100	100	100	100	100	100	100	100	100
<i>Heart-wood.</i>														
Potash	1.51	11.53	26.60	27.47	12.35	36.47	12.04	29.64	18.85	—	—	—	—	—
Soda	2.82	4.07	3.28	2.09	0.85	0.77	1.14	0.37	2.89	—	—	—	—	—
Lime	11.80	60.26	35.10	19.73	68.62	23.80	72.88	44.30	40.06	—	—	—	—	—
Magnesia ..	21.97	19.94	12.90	25.46	10.49	23.41	3.39	18.49	12.06	—	—	—	—	—
Ox. of magnesia	—	—	1.09	—	—	—	—	—	5.65	—	—	—	—	—
Oxide of iron ..	1.79	1.59	3.09	4.13	0.61	1.24	0.75	2.23	9.45	—	—	—	—	—
Phosphoric acid	27.42	1.41	14.23	10.50	7.18	9.36	7.18	1.97	8.36	—	—	—	—	—
Sulphuric acid	—	0.58	2.36	7.57	—	1.16	0.98	0.80	2.67	—	—	—	—	—
Silicic acid ..	32.68	0.63	1.30	3.05	—	3.60	1.65	2.20	—	—	—	—	—	—
Total	100	100	100	100	100	100	100	100	100	—	—	—	—	—
Ash p.c. of wood, sap	0.74	0.5	0.5	2.06	0.97	1.22	0.8	0.64	0.47	6.3	—	8.0	3.9	—
Ash p.c. of wood, heart.	1.0	3.9	0.3	1.73	—	1.75	3.1	0.59	0.32	—	—	—	—	—

and the readers will be duly apprised of further results. I may mention that the quartz fused *per se* is found to have a sp. gr. of 2.06 to 2.07, it being changed into a colloid form, which is no longer quartz. Portions of it are found to have sublimed and condensed in botryoidal forms, transparent and glossy, like hyalite. The groups of silicon crystals, seldom more than 0.001 m. in diameter, are beautiful. There are also fused masses apparently of crystalline silicon, of 0.010 diameter.—T. S. H.

THE application of electricity in the extraction of metals has hitherto been chiefly confined to the electrolysis of dissolved or fused compounds of these by various methods. The power of electric currents to generate intense heat in their passage through a resisting medium has, however, long been known, and the late Wm. Siemens thereby succeeded in fusing considerable quantities of steel. It was, however, reserved to Messrs. Eugene and Alfred Cowles, of Cleveland, Ohio, to take a new step in the metallurgic art by making the heat thus produced a means of reducing, in the presence of carbon, the oxides not only of the alkaline metals, but of calcium, magnesium, manganese, aluminum, silicon, and boron, with an ease which permits the production of these elements and their alloys with copper and other metals, on a commercial scale. In the apparatus devised and now employed by the Messrs. Cowles, a column of fragments of well-calcined charcoal, so prepared and arranged as to present the requisite electrical resistance, is imbedded horizontally in finely-pulverised charcoal, and covered by a layer of the same material coarsely broken, the whole being arranged in a box of fire-brick covered with perforated tiles, and opened at the end to admit two carbon electrodes an inch and a half in diameter. Through these the current from a dynamo-electric machine of 30 horse-power is now made to traverse the central core of carbon, whereby such a temperature is at once produced therein that platinum-iridium may be instantly melted, and the most refractory oxides already named may be not only fused and volatilised, but reduced to their elemental state with formation of carbonic oxide gas.

If alumina in the form of granulated corundum is mingled with the carbon in the electric path, aluminum is rapidly liberated, being in part carried off with the escaping gas and in part condensed in the upper layer of charcoal. In this way are obtained considerable masses of nearly pure aluminum, and others of a crystalline compound of the metal with carbon. When, however, a portion of granulated copper is placed with the corundum an alloy of the two metals is obtained, which is probably formed in the overlying stratum, but at the close of the operation is found in fused masses below. In this way there is got, after the current has passed for an hour and a half through the furnace, from 4 to 5 pounds of an alloy containing from 15 to 20 per cent of aluminum, and free from iron. On substituting this alloy for copper in a second operation a compound with over 30 per cent is obtained. Already the small experimental plant with a 30 horse-power dynamo is producing daily over 5 pounds of aluminum in the form of a rich and brittle alloy, which, by suitable addition of copper, is converted into different grades of aluminum bronze. The valuable qualities of these are so well known that it is only their great cost hitherto which has prevented their more general use in the arts.

The reduction of silicon is even more easy than that of aluminum. When siliceous sand mixed with carbon is placed in the path of the electric current a part of it is fused into a clear glass, and a part reduced with the production of considerable masses of crystallised silicon, a portion of this being volatilised and re-converted into silica. By the addition of granulated copper there is readily formed a hard brittle alloy, holding 6 or 7 per cent of silicon, from which silicon bronze can be very easily made. The reduction of clay gives an alloy of silicon and aluminum, and with copper a silico-aluminum bronze,

which appear to possess properties not less valuable than the compounds already mentioned. Even boric oxide is rapidly reduced with evolution of copious brown fume, and the formation, in presence of copper, of a boron bronze, which promises to be of value; while under certain conditions crystals of what appear to be the so-called adamantoid boron are formed. In some cases also crystalline graphite has been produced, apparently through the solvent action of aluminum upon carbon.

Remarkable results are got by allowing small quantities of aluminum with an admixture of copper and nickel. One of these compounds broke with a strain of 111,000 pounds to the square inch, with an elongation of 35-100ths, while a 10 per cent aluminum bronze broke with 109,000 pounds. An addition of 2 or 3 per cent of aluminum to brass greatly increases its tensile strength, and renders it less susceptible to oxidation. While 15 or 20 per cent of aluminum with copper yields a brittle compound, an addition of 10 per cent of copper gives to pure aluminum a great increase of hardness and tenacity, forming an alloy which may have a wide application. It may be added that the difficulties in the way of gathering together the reduced aluminum without the aid of copper promise to be overcome at an early day, so that we may expect the cheap production of such alloys, and of pure aluminum.

The Messrs. Cowles, in their later work, have been aided by the chemical skill of Prof. C. F. Mabery, now of Cleveland, who is associated with them in some of their patents. These now cover not only the reduction of aluminum, silicon, and boron, as above described, but the reduction of manganese, magnesium, and the alkaline metals by the electric furnace. I had the pleasure of hearing Prof. Mabery give the first scientific notice of this discovery, before the American Association of Science at Ann Arbor, August 28th, and I then spoke of the early results of Deville and those of Debray on aluminum and its alloys, having myself witnessed many of the experiments of both these chemists. I then insisted that the importance of this new instrument which the Messrs. Cowles have placed in the hands of chemists, for producing and controlling degrees of temperature never before obtained, can scarcely yet be estimated either in its economic or its scientific aspect. The heat of this furnace realises the dream of the alchemist, or universal solvent of the alchemists, and he who can rightly use it will be worthy of the ancient title of "magister magnus in ignis." I then suggested trials for the reduction of titanium both from ruti and from titanite iron ore, which will soon be made. I may add that, through the courtesy of these gentlemen, I have since been enabled to spend two entire days in their experimental works at Cleveland, with the Brothers Cowles and Prof. Mabery, when they explained to me several points not yet made public, and allowed me to direct experiments with one of their furnaces. The fusion of quartz and the reduction of silicon without the presence of copper was repeated, as also the reduction of boron and the formation of boron bronze, with many other interesting experiments.

The present plan at Cleveland is but a first experimental one, and has only been in operation a few months. The Cowles Electric Smelting Company have secured a large water-power at Lockport, New York; and a dynamite electric machine of 125 horse-power is now building for them at the Brush Works in Cleveland, which will soon be in operation at Lockport, and will permit of the establishment of the electric furnace on a large scale.

Decomposition of Potassium Iodide.—P. Guyot.—According to Vogel, potassium iodide, if heated along with silica, gives off much free iodine. Guyot finds that this same salt rubbed up with a little ferric oxide and heated over a Bunsen burner instantly evolves iodine.—*Journ. de Pharm.*, No. 6.

A CATALOGUE OF CHEMICAL PERIODICALS.

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.

(Continued from page, 224.)

168. *TECHNISCH-CHEMISCHES JAHRBUCH*. Herausgegeben von Rudolph Biedermann. 5 vols., 16mo. Berlin 1880-'84+

This forms the second part of the Chemiker Kalender. Herausgegeben von Rudolph Biedermann. 5 vols., 16mo. Berlin, 1880-'84+

169. *TEKNO-KEMISK JOURNAL*. P. O. Almström. Stockholm, 1847-'48.

THOMSEN, A. (AND J.).
See Tidsskrift for Physik og Chemi.

THOMSON'S ANNALS.
See Annals of Philosophy.

THUDICHUM, J. L. W.
See Annals of Chemical Medicine.

170. *TIDDSKRIFT FOR ANVENDT CHEMI*, for fabrikanter, kemikere, pharmaceuter og handlende. Udgivet af T. Holm og A. E. M. Schleisner. 1 vol., 8vo. Kjobenhavn, 1869, '70.

171. *TIDSSKRIFT FOR PHYSIK OG CHEMI SAMT DISSE VIDENSKABERS ANVENDELSE*. Udgivet af A. og J. Thomsen. 9 vols., 8vo. Kjobenhavn, 1862-'70. Anden Række. 12 vols., 8vo. 1871-'82+

172. *TIDDSCHRIFT VOOR WETENSCHAPPELIJKE PHARMACIE*, benevens mededeelingen over chemie, pharmacie en pharmacognosie van het planten-, dieren- en delfstoffelijk rijk. Geredigeerd door P. J. Haaxmann. 5 vols., 8vo. Voorburg, 1849-'53.

Tweede serie. 5 vols., 8vo. 's Gravenhage, 1854-'58.

Continued under the title:

[a] *Tijdschrift voor wetenschappelijke pharmacie*. Geredigeerd door P. J. Haaxmann, bevattende de mededeelingen der Nederlandsche maatschappij ter bevordering der pharmacie. Derde serie. 6 vols., 8vo. Gorinchem, 1859-'64.

Nieuwe serie. 9 vols., 8vo. Gorinchem, 1865-'73.

TILLOCH, ALEX.
See Philosophical Magazine.

173. *TOEGEPASTE SCHEIKUNDE*. Tweemaandelijksch tijdschrift, bevattende mededeelingen uit het gebied der toegepaste scheikunde voor het algemeen. Onder redactie van R. J. Opwyda. 5 vols., 8vo. Vlaardingen, 1865-'69.

Nieuwe serie. 4 vols., 8vo. 1870-'75.

Continued under the title:

[a] *Maandblad voor toegepaste scheikunde*, bevattende mededeelingen uit het gebied der toegepaste scheikunde voor het algemeen. Redacteur: R. J. Opwyda. Tredie serie. 5 vols., 8vo. Amsterdam, 1876-'80 (+?).

(To be continued.)

The Presidency of the Royal Society.—Professor Huxley has formally resigned this office, as failing health renders him incapable of discharging its many and onerous duties. In accordance with a judicious custom the Presidency is held alternately by a physicist and a naturalist,—taking these two terms in their widest sense. The council have therefore nominated Dr. Stokes Professor Huxley's successor, and there can be no doubt but that he will be unanimously elected. We think not only the Society, but British Science in general, may be congratulated on this selection. Since the days of Newton the Presidential chair has been occupied by no physicist his superior, even if his equal. An additional recommendation of Dr. Stokes is that he is free from even the suspicion of bureaucratic leanings.

CORRESPONDENCE.

BORONEISEN.

To the Editor of the Chemical News.

SIR.—While engaged some time since in experimenting upon the element boron, I obtained an interesting product, consisting of the element combined with iron, which I have since termed boroneisen. This boroneisen in physical properties corresponds to the well-known compound spiegeleisen, and melts at a temperature between that of steel and ferromanganese. I have obtained specimens containing from five to three per cent of boron, which by suitable means may be isolated in the amorphous condition; I may also venture to say that boroneisen may, if required in large quantities, be obtained at a cost less than that of ferromanganese, its general action being to harden iron and form a boron steel.—I am, &c..

H. N. WARREN.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 16, Oct. 19, 1885.

Electrolysis of Salts.—Ad. Renard.—In solutions sufficiently dilute the quantity of metal precipitated is proportional to the concentration of the liquid. The proportions of metal deposited are in the same relation as their atomic weights. According to the law of Faraday the quantity of metal precipitated being proportional to the intensity of the current, the conductivity of solutions containing equivalent atomic weights of metal is the same, as M. Bouty has demonstrated by a direct method.

Combination of Neutral Magnesium Carbonate with Potassium Bicarbonate.—R. Engel.—The alkalimetric standard of the potassium bicarbonate being the same the speed of the reaction decreases as the temperature rises. The temperature being the same, the speed of the reaction increases with the original proportion of potassium bicarbonate in the liquid. The combination of magnesium carbonate with potassium bicarbonate is limited. The limit of combination measured by the proportion of potassium bicarbonate remaining in presence of an excess of magnesium carbonate without combining with it increases with the temperature. The product of the combination of the neutral magnesium carbonate with potassium bicarbonate decomposes in presence of water.

Falsifications of Alimentary Olive Oils.—A. Audougnaud.—The author takes a test-tube, 0.15 metre in length and 1.015 metre in diameter, graduated into c.c. He measures off 2 c.c. of oil, adds 0.1 grm. potassium bichromate in powder, and shakes the tube for a few moments without closing it. He then pours in nitrosulphuric acid so as to make up a total volume of 4 c.c. He shakes again, when the liquid turns a reddish brown. After resting from 1 to 2 minutes he adds common ether at 65°, so as to make up the volume to 5 c.c. A final agitation mixes the whole. On standing the greenish liquid tends to divide into two strata. In a few moments a brisk effervescence sets in, with the escape of red vapours, and finally the oil floats on the surface with a peculiar colour. With pure olive oil the colour is green. With an oil containing at least 5 per cent of oils of sesame, earth-nuts, and cotton the colour varies from greenish yellow to yellow and even reddish yellow, according to the nature and the proportion of the mixture. The better to appreciate these colours I add water up to the tenth division of the tube. The oil rises and preserves the same characters for some hours.

Biedermann's Central Blatt fur Agrikultur Chemie,
Vol. xiv., Part 4.

Researches on the Capillary Conduction of Water.—E. Wollny.—Among the author's principal results are that the water rises higher the finer are the particles of the soil. The removal of the water takes place the more slowly the higher it has risen. This delay is manifested the earlier the coarser is the texture of the soil. Water sinks down into the soil the more quickly the coarser the particles. The penetration of the water into a material composed of different sized granules ensues at the mean speed. The height which water reaches is diminished by the non-capillary spaces existing in a crumbly soil, and its upward movement is delayed, and this the more the longer these hollow spaces. The downward movement of the water is accelerated by the non-capillary hollows of the soil, and its rapidity is not affected by the size of the granules. Capillary spaces in the soil of a certain magnitude—probably such corresponding to a size of granules of 0.05 to 0.01 m.m.—conduct water most rapidly. The capillary conduction of water in granular soil is accelerated by compression. Water rises the higher in a soil by capillary attraction the denser its texture. Stones occurring in a soil retard the capillary rise of the water. The capillary conduction of water takes places best in quartz, less well in humus, and worst in clay. In mixtures of clay and humus an acceleration of the movement of the water takes place the larger the proportion of the clay. All other things being equal water is conducted more slowly in a limey soil than in one free from lime. The rising and sinking of water in stratified soils takes place much more readily from a coarsely-granular to a finely granular layer than in the reversed order. The capillary conduction of the water in soils is retarded by soluble salts, and in a higher degree by the non-absorbable than by the absorbable salts.

Composition of Horse-chestnuts.—Dr. J. Hanamann.—Air-dried horse-chestnuts are about as nutritious as bruised barley, and contain 1 part of proteine to 7 of non-proteine. It is to be noted that, like sweet chestnuts, they contain the largest proportion of proteine when grown upon siliceous soils free from lime.

ERRATA.—Vol. lii., p. 7, col. 2, line 18 from bottom, for "acid;" read "acid." Line 20 from bottom, for "ones, provided" read "ones. Provided." Page 8, col. 1, line 21 from bottom, for "nitrous" read "nitric." Line 36 from top, for "Schmidzu" read "Shimidzu." Page 9, col. 1, line 31 from top, for " $2(\text{HONH}_3)\text{NO}_3$ " read " $2(\text{HONH}_2)\text{NO}_3$ ".

NOTES AND QUERIES.

** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Imported Soda-ash.—It is roundly asserted that soda-ash is being imported here from Germany. I can hardly believe such to be the case with the present low price of that material. Will some correspondent inform me whether this is so or not?—M. L.

MEETINGS FOR THE WEEK.

SATURDAY, NOV. 14.—Physical, 3. "On Testing Thermometers at the Melting-point of Mercury," Mr. G. M. Whipple. "On the Electromotive Force of certain Tin Cells," Mr. E. F. Herroun.

TO CORRESPONDENTS.

A Student of Chemistry.—1. The new edition of "Select Methods in Chemical Analysis," by W. Crookes, F.R.S., will be published in a few weeks. 2. There is no special work on the subject.



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THE CHEMICAL NEWS.

VOL. LII. No. 1355.

ON THE MOLECULAR WEIGHTS OF LIQUIDS AND SOLIDS.

EVIDENCE DEDUCIBLE FROM THE STUDY OF SALTS.*

By SPENCER UMFREVILLE PICKERING, M.A.

THE value of those arguments as to the molecular weight of a substance which may be deduced from a determination of the number of replaceable or removable units of any one of the elements which it contains, has long been recognised: it was such arguments, indeed, which formed the firmest ground for the assumption of those views which we at present hold as to the nature of such simple molecules as HCl , H_2O , NH_3 , &c., and indirectly, therefore, of the whole body of chemical compounds in general.

The replacement of separate atoms has been, and probably always will be, of far more extended utility than their removal can be, since it is only in a very few cases that the removal of a single atom from a molecule does not leave a residue which is incapable of separate existence: a list containing some of the higher oxides, sulphides, and oxy-acids would almost sum up those cases where this latter method is even *possibly* applicable, and in many of these cases the results obtained may be due to the intervention of secondary reactions, and not to direct removal, thus rendering the conclusions to be deduced from them ambiguous.

One instance in point I had the honour of bringing before the Chemical Society (*Journ. Chem. Soc. Trans.*, 1881, 401), namely, that of cupric sulphide. Hydrogen was found to remove the sulphur from this compound in two distinct stages, at temperatures 400°C . apart, and this clearly indicated that the sulphide must contain at least two atoms of sulphur, necessitating a duplication of the formula CuS generally assigned to it.

I. Hydrated Salts.

Although the value of such methods as applied to atomic compounds is fully recognised, its applicability to so-called molecular compounds would seem to be often denied, and we continually find hydrated salts represented as containing half molecules of water, in violation of all our fundamental ideas as to the indivisibility of atoms. It is surely perfectly evident that a salt which contains such a proportion of water must have its molecular weight doubled; and the important bearing which a number of well-established cases of this kind must have in determining the molecular weights of salts in general can hardly be overlooked.

In conjunction with Mr. A. W. Bishop, of the South Kensington Schools, to whom I wish to express my thanks for the ready and valuable assistance which he has given me, I have collected together all those instances where the water present would necessitate a higher molecular weight than that usually assigned to the compound. Omitting for the present such substances as are obtained by dehydration, they amount to some 50 or 60, of which about 10 are basic salts, 20 double salts, and 6 oxides. But it is impossible to ignore the fact that the existence of many of these rests on a very infirm basis, they being amorphous precipitates or crystalline masses dried under some uncertain conditions. The number of substances whose supposed individuality is dependent on a single analysis of a chance product is indeed lamentable,

and, though they may redound to the credit of the chemist's ingenuity, will long remain as a blot on his scientific character.

The smallness of the number of these hydrates, in comparison to those which do not necessitate an increase in the usual molecular weights, must form a strong argument against drawing any general conclusions from their existence. It is evident that if the sulphates, for instance, really consisted of double molecules, such as 2MgSO_4 , they would in all probability form as many hydrates containing uneven as even numbers of water molecules, but as a matter of fact it is only out of many hundreds of hydrated salts that we can find one with an uneven number, and it is more rational to explain the existence of this one as being unusual, than to double the molecular weights of all the rest on its account. There is no reason for supposing that a substance the molecule of which is $\text{M}'\text{SO}_4$ may not *occasionally* enter into a more complicated state of aggregation, forming a hydrate such as $2\text{M}''\text{SO}_4\cdot\text{H}_2\text{O}$.

The borates deserve some special notice. There is a considerable number of well-defined hydrated meta-borates in which the water present necessitates a doubling of the simplest empirical formula. It would appear as if such salts never contained less than two atoms of a monad metal, their general formula being—



in which x ranges from 0 to 3, possibly to 5. Such a view would necessitate at least a duplication of the formula HBO_2 : this, however, may be easily represented as the result of a condensation of two or more molecules of the ortho-salt by the abstraction of the elements of water from them.

The meta-stannates, the acid meta-antimonates, and the polymeta-phosphates may be regarded as having similar constitutions: with the phosphates we can apparently get salts which are polymers, whereas in the other cases the difficulty of replacing the whole of the hydrogen in the acid prevents their formation; these salts may, however, in all cases be considered as derivatives of polymeric acids, these acids being actually known in the case of tin. (See Frémy, *Ann. Chim. Phys.*, (3), xii., 316, 462, 357; xxii., 404; xxiii., 393; Hefter, *Pogg. Ann.*, lxxxvi., 411; Weber, *Pogg. Ann.*, cxvii., 358; Rose, *Pogg. Ann.*, ix., 76; lxxxvi., 581; lxxxvii., 1, 470, 587; lxxxviii., 299, 482; xci., 452; &c.)

Guthrie's cryohydrates I have omitted in the foregoing summary. If they prove anything at all they prove too much, for the water present in them bears no molecular relation whatever to the salt, and it is difficult not to agree with the conclusions of Offer and others (*Wien. Akad. Ber.* [2], 81, 1058) as to the non-existence of such bodies.†

* Many of these might be regarded as orthoborates, in which case the empirical formula of orthoboric acid would have to be increased.

† The facts on which Guthrie relies as proving that these substances are chemical compounds must inevitably exist, even if they are mere mixtures. Starting with a weak solution, the excess of water must separate out as ice when it is cooled, the solution becoming more concentrated meanwhile. Starting, on the other hand, with a strong solution, the excess of salt will separate out under a similar treatment, the solution becoming weaker. Between a weak and strong solution there must be in each case a degree of concentration when neither the water nor the salt is in excess, and on cooling such a solution both of these will separate out simultaneously without any change in the strength of the liquid. These solidified mixtures will necessarily have an invariable composition, and the temperature of their solidification and fusion must always be the same; this temperature, moreover, is of necessity identical with that produced by mixing ice with the salt in question. The absorption of heat on making such a mixture is in every case sufficient to lower the temperature to this point, and, though it might be sufficient to lower it still further, it can never do so, for a further absorption of heat would result only in the solidification of some of the liquid, and not in an abatement of temperature. Offer shows that the form of the crystals obtained is generally that of ice, or some modification of this form; that they are always opaque, even when formed very slowly; that water dissolves out the salt from them, leaving a skeleton of ice; and that alcohol dissolves out the ice, leaving a skeleton of the salt. He also proves that their volume is exactly the sum of the volumes of the salt and ice mixed, and that their heat of dissolution is identical with the sum of those of the salt and ice,—i. e., that no heat evolution occurs in their formation.

* A Paper read before Section B, British Association, Aberdeen Meeting.

2. Basic Salts.

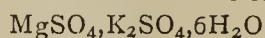
These may, for many reasons, be considered as analogous to hydrated salts, consisting of a molecule of the normal salt combined with molecules of the metallic oxide instead of water (*vide infra*); and the arguments deducible from them will be precisely similar to those deducible from hydrates.

I have been able to find only about twenty of these salts in which the proportion of metallic oxide would necessitate a multiplication of the usually adopted molecular weights; a small proportion of the many hundreds which have been described.

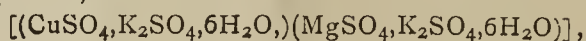
I cannot hesitate, however, to attribute but little or no weight to any arguments deduced from these compounds, since a thorough examination which I undertook of the basic sulphates of iron, aluminium, and copper showed that out of the thirty of these salts which were said to exist, only three in reality did so, the others being nothing but mixtures (*Journ. Chem. Soc. Trans.*, 1880, 807: *CHEMICAL NEWS*, xlv., 121, 133, 146; xlvii., 181).

3. Double Salts.

The line of argument which may be taken from the existence of double salts is briefly this:—If two somewhat *similar* molecules, such for instance as CuSO_4 and MgSO_4 , can combine together to form a double salt, their doing so would favour the idea that two *identical* molecules could do likewise, the double salt being in fact a simple replacement product of the double molecule 2CuSO_4 . Now the number of double salts which have been described is very great, the sulphates constituting, perhaps, as large a class as any others, for a description of which we are indebted chiefly to Vohl (*Ann. Chem. Pharm.*, xciv., 57). The double salts of the type—



may well be regarded, as Graham (*Trans. Roy. Soc. Edin.*, xiii., 297, and *Chem. Soc. Mem.*, i., 106) originally considered them, to be derivatives of the hepta-hydrated magnesian sulphate, in which K_2SO_4 has replaced H_2O , and, therefore, they scarcely form a case in point; similarly also with the alums. These double salts, however, are said to combine together, forming more complicated compounds, such as—



which may be termed double-double salts derivable from a double molecule of $\text{CuSO}_4, \text{K}_2\text{SO}_4, 6\text{H}_2\text{O}$, and of these Vohl has described forty-two preparations, and, besides some triple and quadruple double salts of the same type, he also obtained double, triple, and quadruple alums, as well as various double and triple magnesian sulphates, such as $[(\text{MgSO}_4, 7\text{H}_2\text{O})(\text{FeSO}_4, 7\text{H}_2\text{O})]$. Vohl's analytical numbers are all that could be desired, and indeed more than might have been expected at the date of his work (1855). But an investigation which, in conjunction with Miss Aston, of Bedford College, I have just completed, must throw considerable doubt on this formidable array of complex salts. Although there certainly is some evidence as to a tendency towards combination, in the facts that the presence of the salt $\text{CuSO}_4, \text{K}_2\text{SO}_4, 6\text{H}_2\text{O}$ will induce the salt $\text{MgSO}_4, \text{K}_2\text{SO}_4, 6\text{H}_2\text{O}$ to crystallise out from a solution too dilute to yield it of its own accord, and that either the copper or magnesium sulphate will in each other's company crystallise out with a proportion of water and in a crystalline form foreign to its usual nature, still the tendency to combine is so weak that any alteration in the conditions of their preparation will cause a corresponding alteration in the composition of the product,—in other words, any salt corresponding to the required formulæ can only be obtained as a chance product. If, then, the tendency which *similar* molecules have to combine is so weak that it will not raise the compound to the level of a definite chemical substance, it is highly probable that the tendency of *identical* molecules to combine will be *nil*.

The evidence against Vohl's sulphates, to which I have briefly alluded, must throw a deep shadow of suspicion

on many other double salts. There can, however, be no doubt as to the existence of many perfectly definite double salts and classes of double salts; but if these are in reality derivatives of what may be termed polymolecular single salts (*e.g.*, $x\text{MgSO}_4$), we should expect that the water present in these single salts would also show them to be such. This, however, is not the case; although, for instance, there are many well-authenticated double chlorides, there is not a single case in which the water present in a simple chloride would indicate its having a higher molecular weight. Similar facts hold good with the other double salts,* and force the conclusion on us that their existence can throw no light on the question under discussion.

(To be continued).

TREATMENT AND QUALITATIVE COMPOSITION
OF ZIRCON.

By ED. LINNEMANN.

(Concluded from p. 235.)

I WILL now mention the zirconium acetates. If a neutral solution of zirconium chloride is mixed with a sufficiency of sodium acetate, and the diluted solution is heated for some hours in the water-bath, all the zirconium falls as a bulky, flocculent, zirconium acetate, but by no means free from impurities, although the supernatant liquid is strongly acid from free acetic acid.

The basic acetate is completely dissolved in hot glacial acetic acid, but the hydrate precipitated in the cold is not. From this solution the zirconium acetate is obtained as a brittle chinky mass, in every respect similar to gum arabic. If covered with water this salt first swells up to a translucent jelly, forming a thick glutinous mass, which then becomes a syrup, and ultimately a thick liquid, frothing readily. The attempt to eliminate the crystallisable acetates present in the solution by dialysis miscarried. Even after remaining for weeks upon the dialyser sodium could not be removed.

To obtain a pure preparation of zirconium I tried also the following method:—The neutral chloride, after being again treated with sulphuretted hydrogen, was introduced into a large excess of a saturated solution of ammonium carbonate, and precipitated with ammonium sulphide. The precipitate separated with the necessary precautions—contained, indeed, as the spark-spectrum of its solution showed, iron, zinc, lead, lime, and magnesia; but in the solution there was nevertheless, along with zirconia, still some iron, as well as zinc, lead, copper, lime, and magnesia. Even twice repeated precipitation with ammonia as hydroxide, and washing until the chlorine reaction disappears, did not remove zinc, lime, and magnesia from the zirconia. We thus perceive how difficult it is to remove small impurities of copper, lead, zinc, iron, lime, and magnesia from zirconia by the ordinary methods of separation. The zirconium chloride in question had been treated at least three times with hydrogen sulphide, and precipitated once with ammonium sulphide in a solution of ammonia, and at least five times with ammonia as hydroxide, without being freed from the above-mentioned impurities.

For the complete purification of zirconium chloride I re-crystallised it repeatedly out of hot fuming hydrochloric acid, of sp. gr. 1.17, in which zirconium chloride is perfectly soluble with the aid of heat if the quantity of acid is sufficient. On cooling it separates out to a very great extent. The sparing solubility of ZrCl_4 in strong

* This is so even with the acetates where the vapour density of the gaseous acid would lead us to expect some molecular complications in the liquid and solid acid and its derivatives, unless, indeed, Berthelot's explanation of the anomaly of this vapour density, on the supposition that the free path of the molecule is not a straight line, be correct.

hydrochloric acid has been previously pointed out, and Chevreul and Herrmann have proposed to wash the chloride with such acid as a means of purification. But nothing save re-crystallisation effects this object quickly and completely. The loss is not very great. Thus 79 grms. $ZrCl_4$ after three re-crystallisations, each time from 100 c.c. of hot hydrochloric acid, removal of the mother-liquor, and subsequent washing each time with 50 c.c. of cold hydrochloric acid, yielded 52 grms. purified $ZrCl_4$. The greater part of the $ZrCl_4$ contained in the acid filtered off can be obtained in a less pure state by the addition of alcohol and ether. The ether-alcoholic filtrate gave on concentration a residue, the spark-spectrum of which showed copper, lead, zinc, iron, magnesium, and calcium. These metals could be separated from each other by ordinary processes, so that their very pure and brilliant spark-spectra became visible.

The spark-spectrum of the aqueous solution of the $ZrCl_4$, purified in this manner, showed no longer any single spectral lines, but a continuous spectrum, faint at first, but quickly becoming strong, and due to the zirconia which is formed, and which reaches a white heat. This cir-

than 16 other metals were discovered in addition to zirconium.

If in the $ZrCl_4$ washed with hydrochloric acid, ether, and alcohol, copper, bismuth, and tin were precipitated by means of sulphuretted hydrogen, and subsequently copper, lead, zinc, and iron were separated, the above-mentioned extract itself, on treatment with sulphuretted hydrogen, gave a precipitate containing considerable quantities of tin, smaller ones of copper, and traces of lead, silver, and platinum. The two last metals were derived from the platinum wire used for stirring, and from the silver crucible which contained the melt on opening up the zircons. The precipitate with ammonium sulphide left cobalt as a residue on solution in hydrochloric acid. In the potassic solution of the oxides there was aluminium but no other metal. On treating the ferric hydroxide with ammonium chloride and ammonia there were dissolved cobalt, zinc, manganese, magnesium, and calcium. Manganese was present in traces, copper in small quantities. The precipitation with ammonium chloride and ammonia had to be repeated three times in order to separate the zinc, magnesium, and calcium entirely from the iron.

FIG. A.

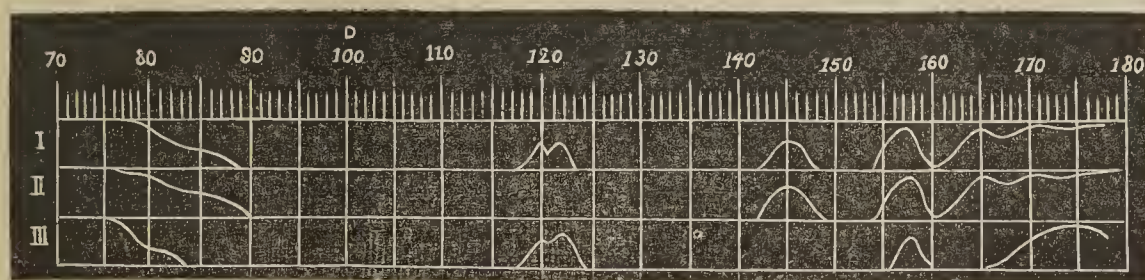


FIG. B.



cumstance justifies me in assuming that the zirconia has lost all its accompanying impurities, as otherwise their bright lines would have been visible at least at the beginning.

Although the aqueous solution of zirconium chloride gave no spectral lines, the dried salt gives in the spark, on breaking contact, a spectrum very rich in lines. Here, also, zirconia at a white heat occasions a strong continuous spectrum. It will, however, be possible with a spectro-scope having powerful dispersive prisms—which are necessary on account of the great proximity of the single lines—to measure a great number of lines, beginning from the green part of the spectrum towards the more refrangible end. I shall on a future occasion revert to the spectrum of pure $ZrCl_4$ in the spark on breaking contact.

The other basic oxides occurring along with zirconia in the main mass of zircon crystals not attacked by hydrofluoric acid were contained in the hydrochloric, ethereal-alcoholic extract. As the total of these chlorides was obtained from 400 grms. of zircon crystals the examination of these chlorides was equal to a complete qualitative analysis. It is not surprising that the results of this analysis were more complete than those of a qualitative examination undertaken with the ordinary quantities. Hence this analysis is of unusual interest, as not fewer

Zinc, magnesium, and calcium could be demonstrated with the utmost distinctness by means of the spark-spectrum of the solution of the chloride. Manganese was less distinct.

The light colour of the ferric hydroxide freed from zinc, manganese, cobalt, calcium, and magnesium indicated the presence of earths. The iron was precipitated by means of ammonium carbonate and sulphide, and separated from the earths. The filtrate on concentration yielded the earths, the yellow colour of which betrayed the presence of uranium. At the same time a little zirconia was present which could be entirely precipitated as basic zirconium sulphate by means of an excess of potassium sulphate at a boiling heat.

The relatively pale colour of the hydroxides precipitated from the soluble sulphates by ammonia pointed to the presence of a further earth along with uranium oxide. It could be separated from uranium, though not quite perfectly, by means of a boiling solution of ammonium chloride, in which uranium oxide dissolves only in traces, and hydrated zirconia not at all. By repeating the operation the earth could be almost entirely separated from the uranium. The earth is erbia, without didymium.

Uranium was recognised by the characteristic uranium reactions which were all obtained, and by the very

characteristic absorption-spectrum of the hydroxide in ammonium carbonate, hydrochloric and nitric acids.

Erbium was recognised by the behaviour of its hydroxide with a boiling solution of ammonium chloride, in which it is readily and completely soluble; by its behaviour with boiling solutions of sodium acetate, when no precipitation takes place, whilst zirconia is entirely thrown down; by the solubility of its sulphate, and the characteristic absorption-spectra of the solutions of the hydrate in ammonium carbonate, in hydrochloric and in nitric acids.

Fig. A shows in No. I. the absorption-spectrum of the erbia from zircons mixed with uranium dissolved in ammonium carbonate, No. II. the absorption-spectrum of a solution of uranium oxide, and No. III. a solution of erbium oxide, both dissolved in ammonium carbonate. As to the occurrence of erbium and uranium in zircons there can hence be no doubt.

As the absorption-spectrum of uranium and erbium chlorides from zircon, Fig. B, No. I., shows at 85 of the scale (approximate wave-length 6590) an absorption-line which belongs neither to uranium chloride (Fig. B, No. II.) nor to erbium chloride (Fig. B, No. III.), a further examination of this subject is desirable with regard also to the question whether any other of the gadolinite earths besides erbium occur in the zircon. Such an inquiry would be the easier, as the separation of the gadolinite earths from zircon can be effected far more simply and completely than it took place in the present research, whilst it was still quite doubtful what might be the nature of the existing oxides. The absorption-line observed ($\lambda=6590$) belongs either to one of the very rare earths, or, more probably,—as this line does not approximate sufficiently to any of the absorption-lines of the rare earths hitherto observed,—to a new metal. For the solution of this question I purpose either to work up considerably larger quantities of zircons or to use such zircons as, like hyacinth and jargon, betray by their absorption-lines a more considerable proportion of uranium and absorbent compounds.

Sorby has observed in certain jargons peculiar absorption-bands, in the red, the green, and the violet part of the spectrum. He regarded this phenomenon as due to the presence of a new element, which he designated jargonium. Afterwards he found that this absorption was due to uranium. Thus is probably explained the absorption in the blue and the red part of the spectrum, but not the absorption observed in the mean green portion of the spectrum.

These absorption-bands are derived, according to my own observations, from erbia, and Sorby's statement that a bead may be obtained by fusing pure zirconia and uranium oxide with borax, which displays analogous phenomena of absorption, is in so far unimportant, as this experiment never succeeded in my hands with my "pure zirconia" and uranium, evidently because erbium was no longer present in the zirconia; the absorptions corresponded merely with the presence of uranium.

I return now to the further result of the qualitative analysis of the hydrochloric ether-alcoholic extract of the crude zircon chloride. From the filtrate after the precipitation with ammonium sulphide a little more cobalt was deposited on boiling. The flame-spectrum showed potassium, sodium, lithium, calcium. The spark-spectrum of the solution indicated magnesium, calcium, potassium, sodium, lithium. In the crystalline main mass of zircon the following metallic elements are therefore present:—

Tin, lead, copper, bismuth, zirconium, aluminium, iron, cobalt, manganese, zinc, magnesium, uranium, erbium, calcium, potassium, sodium, lithium. We see that the designation of zircon as a "polykrasilith" is both justifiable and appropriate.—*Sitz. Berichte Kais.-Akad. der Wissenschaft.*, Vol. ii., 1885.

Manuring Vines with Artificial Manures.—Dr. A. Stutzer.—Artificial manures give a greater average of grapes than farmyard manure, and the sp. gr. of the must is higher.

A CATALOGUE OF CHEMICAL PERIODICALS.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford, Conn.

(Concluded from page 237.)

EXPLANATION OF SIGNS.

- + Following a date signifies current at the date in question.
|| Following a date signifies publication discontinued.

TRIER, S. M.

See Archiv für Pharmaci.

TROMMSDORFF, J. B.

See Allgemeine chemische Bibliothek; also Almanach für Scheidekünstler [b]; also Annalen der Pharmacie; also Journal der Pharmacie für Aerzte und Apotheker.

TROMMSDORFF'S TASCHENBUCH FÜR SCHEIDEKÜNSTLER.

See Almanach für Scheidekünstler.

174. UEBER DIE NEUEREN GEGENSTÄNDE IN DER CHEMIE. Herausgegeben von J. B. Richter. 11 parts 8vo. Breslau, Hirschberg und Lissa, 1791-1802.||

175. UNTERSUCHUNGEN AUS LIEBIG'S LABORATORIUM. 1 vol., 8vo. Wien, 1872.

176. VIERTELJAHRESSCHRIFT FÜR TECHNISCHE CHEMIE, landwirthschaftliche Gewerbe, Fabrikwesen und Gewerbtreibende überhaupt. Unter Mitwirkung mehrerer Gelehrten, Fabrikanten und Techniker, herausgegeben von Wilibad Artus. 10 vols., 8vo. Quedlinburg, 1859-'69.||

WAGNER'S JAHRESBERICHT.

See Jahresbericht über die Fortschritte der chemischen Technologie.

WASSERBERG, F. A. X.

See Beiträge zur Chemie.

WATT, CHARLES (AND JOHN).

See Chemist (The).

WESTRUMB, J. F.

See Kleine physikalisch-chemische Abhandlungen.

WIEDEMANN'S ANNALEN.

See Journal der Physik [c].

WIGNER, G. W.

See Analyst (The)

WÖHLER, FR.

See Annalen der Pharmacie [b].

WOOD (CHARLES H.), AND SHARP (CHARLES).

See Chemist's Desk Companion; also Year-book of Pharmacy.

WURTZ, ADOLPHE.

See Répertoire de chimie pure et appliquée.

177. YEAR-BOOK OF PHARMACY. A practical summary of researches in pharmacy, materia medica, and pharmaceutical chemistry, [in 1881, and transactions of the Pharmaceutical Conference]. Edited by Charles H. Wood and Charles Sharp. 18 vols., 8vo. London, 1865-'82+

Cf. Chemist's (The) Desk Companion.

ZANTEDESCHI, FRANCESCO.

See Giornale fisico-chimico italiano; also Raccolta fisica-chimica italiana.

178. ZEITSCHRIFT FÜR ANALYTISCHE CHEMIE. Herausgegeben von C. Remigius Fresenius. 23 vols., 8vo. Wiesbaden, 1862-'84.

Autoren- und Sach-Register zu den Bänden I.-X. (1862-'71). 1 vol., 8vo. Wiesbaden, 1872.

Autoren- und Sach-Register zu den Bänden XI.-XX. (1872-'81). Bearbeitet von Heinr. Fresenius, unter Mitwirkung von Wilh. Lenz. 8vo. Wiesbaden, 1882.

ZEITSCHRIFT FÜR CHEMIE UND PHARMACIE.

See Kritische Zeitschrift für Chemie.

179. ZEITSCHRIFT FÜR DAS CHEMISCHE GROSSGEWERBE. Kurzer Bericht über die Fortschritte der chemischen Gross-industrie. Unter Mitwirkung von angesehenen Technologen und Technikern, sowie von F. Frerichs, J. Landgraf, K. Polstorff, P. Wagner, H.

* Advance-proofs from the *Annals of the New York Academy of Sciences*.

Wiesinger, F. Wunderlich, herausgegeben von Jul.
Post. 7 vols., 8vo. Berlin, 1876-'82. ||

180. ZEITSCHRIFT FÜR PHYSIOLOGISCHE CHEMIE. Unter
Mitwirkung von E. Baumann, Gähtgens Hüfner,
[etc.], herausgegeben von F. Hoppe-Seyler, 8 vols.,
8vo. Strassburg, 1877-'84+

181. *ZHURNAL RUSSKOVA KHIMICHESKOVA I FIZICHESKOVA
obschetsva pri St. Peterburgskom Universitetye.
16 vols., 8vo. St. Petersburg, 1869-'84+

182. ZPRAVY SPOLKU CHEMIKŮ ČESKÝCH. Rediguje: V.
Safarik. 2 vols., 8vo. v Praze, 1872-'76 [+?]
Cf. Časopis chemiků českých.

PROCEEDINGS OF SOCIETIES.

THE INSTITUTE OF CHEMISTRY.

General Meeting, November 6, 1885.

Dr. ODLING, F.R.S., President, in the Chair.

THE PRESIDENT'S ADDRESS.

THE INSTITUTE OF CHEMISTRY, as a now existing association, only came into being on the 13th day of June of the present year, 1885, when some four hundred of us were incorporated by Royal Charter into a body politic, under the name of the Institute of Chemistry of Great Britain and Ireland; and were entrusted by the charter of our incorporation, alike with certain privileges and with certain public duties and responsibilities. But although as an association now in being we can claim an existence of but a few short month's duration, it is not merely for so brief a period as this that a definite bond associating us with one another in a common work has replaced that informal tie of friendly co-operation which, among the seniors of our body, and among their elders and predecessors, can be traced back for the distance of fully half a century. It chanced, indeed, about nine or ten years ago, as a consequence of occurrences then taking place, that a long pent up feeling of dissatisfaction at the deficiency among us of means for exerting a common action and influence began to manifest itself in a plainly outspoken way. As an outcome of this feeling, a movement was set on foot, more especially by the younger members of our craft, for bringing about a definite organisation of professional chemists. This movement, with which Dr. Frankland, who had long been impressed with a sense of the deficiency, very early identified himself, soon found in him its legitimate leader. After much consideration of various proposed means for carrying out the object desired, a Memorandum of Association was at length drawn up; and eventually, on the 2nd day of October, 1877, and following day or two, some hundred and fifty of us were definitely incorporated under Articles of Association, in accordance with the provisions of the Companies' Act of 1867, and were registered by the same name as that which has been but so lately accorded anew to our body by Royal Charter. Of the circumstances attending the formation of this original Institute of Chemistry, a full account is given in Dr. Frankland's presidential address, delivered at the first general meeting of the Institute, held on February 1st, 1878, the members at that time consisting of 7 Associates and 225 Fellows. The original Institute of Chemistry existed, prospered, and carried on its work for between seven and eight years, until at a

general meeting of the members, held on the 24th of April of the present year, a special resolution was passed requiring that the Institute founded in 1877 should, with a view to re-incorporation on a more satisfactory footing, be voluntarily wound up; and in accordance with this resolution, it was definitely wound up and ceased to exist on the 30th of June last, 1885, although, indeed, certain ceremonial observances pertaining to its obsequies have even yet to be performed. At the time of its dissolution on June 30th, the original Institute of Chemistry consisted of 33 Associates, most of whom had been subjected to examinations conducted by the Institute, and of 403 Fellows, some few of whom had passed through the grade of Associateship.

The original Institute had the advantage of being pioneered during the early days of its existence by its first President, and it might almost be said founder, Dr. Frankland. After him succeeded one who had all along taken an active part and interest in its organisation and welfare, Sir Frederick Abel, to whose loyal and judicious action as President the Institute was largely indebted during a period of its existence when its strength was not fully assured, and when the outburst of enthusiasm to which it owed its origin and early prosperity had in some measure, at least, cooled down. On the termination of Sir Frederick Abel's three years tenure of office I was selected to occupy the position so notably well filled by my two predecessors, whose continued interest in the work of the Council, and alike never-failing personal co-operation with me in the always responsible, and at times anxious, duties of the position to which I succeeded, it is out of my power adequately to acknowledge. With my presidency, the original Institute of Chemistry, as a particular corporate society, has come to an end, and the present Institute, as a technically new corporation, has come into existence.

But though technically a new corporation, the present Institute of Chemistry is in reality a continuation and development of the original association. By a resolution of the expiring Institute, its property was made over to the present Institute; and by a provision of the Royal Charter incorporating the present Institute, the members of the original Institute are constituted the first members of the present Institute; and the President, Officers, and Members of Council of the original Institute are constituted respectively the first President, Officers, and Members of Council of the present Institute, and are charged with power and authority to carry on the work of the present Institute according to the rules and customs of the original Institute, until the Bye-laws of the present Institute have been settled at a general meeting of the members, and have been submitted to, and allowed by, the Lords of Her Majesty's Privy Council. In connection with this subject, it may be well to mention that a meeting of the Council of the present Institute, being as aforesaid the persons who constituted the last Council of the original Institute, was held a week ago on the particular day appointed in the Charter for their first meeting, namely on the last Friday in October, and that at this Council meeting the subject of framing draft Bye-laws for the Institute, to be afterwards submitted to a general meeting of the members, was actively taken in hand; for until our code of Bye-laws has been settled by a specially convened general meeting, been confirmed by a subsequent general meeting, and been sanctioned by the Lords of the Council, no fresh election of President, Officers, and Members of Council of the Institute can validly be held.

By the attainment of our incorporation by Royal Charter, in lieu of the Articles of Association by which we have, until now, been banded together, we become for the first time an officially recognised professional body, known officially to Government, and both to municipal and to other professional bodies. Further than this, we have had formal acknowledgment made of our fitness to be charged with certain public duties and responsibilities, and have established our claim to be entrusted with correlative rights and privileges. Our profession, the public utility and

* Attempts to transliterate Russian are very unsatisfactory; instead of rendering the title phonetically, as above, it may be given literally thus:—Journal russkago khimicheskago i fizicheskago obschetsva, [etc.].

importance of which have, in this way, received at length so formal a recognition, is one that we may all of us feel a just pride in belonging to. It is not indeed with bated breath that we need speak of ourselves as professional chemists. Chemistry, indeed, as a branch of knowledge, pertains not alone to the student, but exists also for the practitioner, and still more for the public. Of exceptional interest as a subject of study, it is of scarcely less interest from its manifold practical applications, and as a contributor to the daily wants and enjoyments of the community, a community in which all are bound up with one another, and are under obligation to render services to one another. Nowadays, the ever extending and increasingly complex wants of the community create a greater and greater demand for what are known as professional services, and for professional services of a kind and extent that cannot be rendered by the parson, or the doctor, or the lawyer; or yet by the amateur engineer, or the amateur electrician, or the amateur chemist. It is the competent services of professional men, specially trained in their several departments, that are alone adequate, and are alone accordingly in request. To the trained professional chemist, as to other professional men, interests of occasionally enormous value are committed; and some notion of the consideration in which his work is held may be gathered from the extensive resort had everywhere to his services, even by the great departments of State and by the most renowned and important of municipal and other corporations.

Among Government Departments, the War Office, the Home Office, the Board of Trade, the Local Government Board, and the Board of Inland Revenue, have each their respective permanently attached staffs of professional chemists, with whom from time to time, in relation to special subjects of enquiry, other chemists of distinction are associated. Among corporations and public institutions of all sorts, the City of London, the Metropolitan Board of Works, most of the great provincial Corporations and Local Boards, the Royal Mint, the Houses of Parliament, the Elder Brethren of the Trinity House, the Thames Conservancy, the Royal Agricultural Society, the great Gas and Water Companies, the different Metropolitan Vestries and Local Boards, and many more such bodies, have recourse alike to the regular services of their permanently attached professional chemists, and to the supplementary services of various others among us whom they find it necessary to call into consultation from time to time. And of yet greater extent as a whole is the habitual resort that is had to the services of the professional chemists by mercantile and manufacturing firms and associations, engaged in almost every variety of commerce, manufacture, and industrial enterprise. Alike, then, by the great departments of State, and by commercial firms of world-wide renown, and by traders and producers occupying a less distinguished position, the multifarious services of the chemist are ever in request. And in respect to ourselves, by whom these services are rendered, from those of us occupying the leading positions in the profession, to the most humble individuals practising in our ranks, we are all associated in a common work, and have all a common credit to maintain, and are all under mutual obligation to co-operate with and advance the interests of one another.

It would seem, however, from observations not unfrequently hazarded by some very superior persons, whose happy mission it is to put the rest of the world to rights, that there is something derogatory to the man of science in making his science subservient in any way to the requirements of his fellows, and thereby contributory to his own means for the support of himself and of those depending upon him. Now, on this not uncommon cant of the day, a little plain speaking would seem to be very much wanted. While the investigation of nature and the interpretation of natural law are admittedly among the highest, as they are among the most delightful of human occupations, the right application of natural law to effect desirable objects is in itself a scarcely less worthy occupa-

tion; many of these objects being of paramount importance, and attainable only by the exercise of high scientific sagacity and skill, aided by a fertility of resource and a persistent elasticity of spirit, ready ever to cope with the successive novel difficulties found to be continually opposing themselves.

In this matter, as in so many others, the sense of proportion is but too often lost sight of. Because the investigations of a Newton, a Darwin, a Dalton, a Joule, and a Faraday have an importance of which few among us can adequately conceive even the measurement; because among the scientific men now or but lately living in our midst are to be found those whose investigations in pure science have not only won for them a high renown, but have earned for them the gratitude, and should have obtained for them the substantial acknowledgments of their country and the world; and because even the minor investigations and discoveries that are ever being made in pure science have all of them their merit and their value, it does not follow that the mere accomplishment, it may be in an abundant leisure, of two or three minor investigations, however creditably conducted, are to lift their authors into a scientific position, altogether above that of men whose laborious lives have been spent in rendering their great scientific attainments directly serviceable to the needs of the state and of the community. The accomplishment of such like investigations does not entitle their authors to claim exemption from the duty of earning their own livelihoods, or give them a claim to be endowed by the contributions of others with the means to jog leisurely along, without responsibilities and without anxieties, the far from thorny paths of their own predilection. However heterodox it may be thought by some, the best of all endowments for research is unquestionably that with which the searcher, relying on his own energies, succeeds in endowing himself. The work to which our natures are repugnant, not less than the work which entrances us and hardly makes itself felt as a work at all, has to be done. In some degree or other, we have most of us to obtain our own livelihood; and harsh as may seem the requirement, it will, I suppose, be conceded that the necessity put upon the mass of mankind, of having to earn their daily bread, is an arrangement of Providence which has, on the whole, worked fairly well; and further, that the various arrangements hitherto tried for exempting certain classes of men from the necessity of having to earn their daily bread, in order that they might give themselves up to the higher spiritual or intellectual life, have scarcely, to say the least of them, worked quite so satisfactorily as they were intended to. All of us are, without doubt, qualified for higher things than the mere earning of our daily bread; but the discipline of having to earn our daily bread is, in more ways than one, a very wholesome discipline for the mass of us, and even for the best of us. It may here and there press hardly on particular natures, but it is rarely an impediment to the achievement of the highest things by those having the moral qualities, the judgment, the determination, and the self-denial necessary above everything else for their achievement. Not a few of us may consider ourselves fitted for higher work than the gods provide for us, and fondly imagine what great things we should effect if we could only have our daily bread supplied to us by the exertions and endowments of other less gifted mortals. But experience is not on the whole favourable to the view that, the conditions being provided, the expectation would be realised. Experience, indeed, rather favours the notion that it is primarily the necessity for work, and association with those under a necessity to work—those in whom a professional spirit has been aroused, and by whom work is held in honour—that creates and keeps up the taste and the habit of work, whereby the vague ambition to achieve is turned to some productive account. Take, say, a thousand of the most eminent men the world has produced, and making no allowance for the large influence of descent or training, or of association with those to whom work is a necessity, or having

been a necessity has become a habit, consider what proportion of these men have, by their means and position in early life, been free from any stimulus or obligation to exert and cultivate their powers; and consider, on the other hand, what proportion of them have been stimulated to exertion and success by the stern necessity of having either to achieve their own careers, or to drop into insignificance, if not indeed into actual or comparative degradation and poverty. We ought, indeed, all of us to be students, and to be above all things students; but the most of us cannot be, nor is it desirable, save in the case of a special few, that we should be only students. We have all our duties to fulfil in this world, and it is not the least of these duties to render ourselves independent of support from others, and able ourselves to afford support to those depending upon us. Fortunate are we in being able to find our means of support in the demand that exists for the applications of a science which has for its cultivators so great a charm. To judge, however, not indeed by their coyness when exposed to the occasional temptation of professional work, but rather by their observations on the career of others, the most sought after and highest in professional repute, the pursuit of professional chemistry is, in the opinion of some among us, a vocation open to the gravest of censure. It is praiseworthy, indeed, for the man of science to contribute to his means of livelihood by the dreary work of conducting examinations in elementary science for all sorts of examining boards, and by teaching elementary science at schools and colleges, and by giving popular expositions of science at public institutions, and by exchanging a minor professorial appointment affording abundant opportunities for original work, in favour of a more lucrative and exacting appointment involving duties which, if rightly fulfilled, must seriously curtail these same opportunities. It is praiseworthy of him to add to his means by compiling manuals of elementary science, and by writing attractive works on science for the delectation of general readers; but it is forsooth derogatory to him, if not indeed a downright prostitution of his science, that he should contribute to his means of livelihood by making his knowledge subservient to the wants of departments, corporations, and individuals, alike of great and small distinction, standing seriously in need of the special scientific services that he is able to render them.

A glance back suffices to show how foreign to the ideas of the great men who preceded us is this modern notion of any reprehensibility attaching to applied or professional science. In his earlier days, Professor Faraday was largely employed in connection with all sorts of practical questions, and until almost the close of his life continued act as scientific adviser to the Trinity House. No man was more constantly occupied in advising with regard to manufacturing and metallurgic and fiscal questions than Professor Graham, who ended his days holding the official position of Master of the Mint; a position in which he succeeded another eminent man of science, less known, however, as a chemist than as an astronomer, Sir John Herschell. As in these typical instances, so also in very many others; and if I may be allowed to draw at all on my own personal experiences, I would say that some of the most pleasant remembrances of my past life relate to the occasions on which I had the good fortune, early in my career, to be brought into association as a junior professional colleague, with some among the then most eminent of scientific men. It did not indeed happen to me to be associated in this particular manner with Faraday, or Graham, or Daniel, or yet with their frequent colleague Richard Phillips, one of the early Presidents of the Chemical Society, for many years the able and omiscient editor of the *Philosophical Magazine*, and the leading professional chemist of his day. But among those who have passed away from us altogether, or have for some cause or another quitted our ranks, my recollection goes back to professional association with a host of distinguished men of science; whose membership would, of itself, suffice to

ensure an honourable estimation for any profession to which they belonged. On different occasions it has been my lot to be engaged in advising on various questions in conjunction with Arthur Aikin, a personal friend of Priestley, writer of a still valuable dictionary of chemistry, the first Treasurer of the Chemical Society, and for many years the leading authority in regard to chemical metallurgy; with Dr. Thomas Anderson, of Glasgow, an assiduous and successful worker in the then unfamiliar field of organic chemistry, and for many years consulting chemist to the Highland Society; with Professor Brande, the pupil and successor of Davy, at the Royal Institution, long time one of the Secretaries of the Royal Society, an early President of the Chemical Society, and in his professional capacity, Director of the Die Department at the Royal Mint; with Sir Robert Christison, of Edinburgh, one of the most scientific of British toxicologists and pharmacologists, an original worker in many fields of inquiry, President of the Royal Society of Edinburgh, and a selected, though not an actual, President of the British Association; with Dr. Warren de la Rue, the friend of us all, more than once President of the Chemical Society, and a Vice-President, Medallist, and Bakerian Lecturer of the Royal Society; with Dr. Hofmann, the first Professor at the College of Chemistry, and Assayer for many years to the Mint, one who can claim so many of us as his pupils, and who as a professional chemist, no less than as an investigator and teacher, ever set an example of energy and vivacity to all his associates, working on one occasion the long night through in order to extract from paraffin oil a specimen of benzene, ready for exhibition in Court on the following morning, an instance of professional devotion which, as the presence of my immediate predecessor, Sir Frederick Abel, reminds me, is not wholly without a parallel. Proceeding in my enumeration, I may mention Sir Robert Kane, then of Cork, a teacher and worker of originality and wide erudition, to whom chemists are indebted for their now familiar conception of amidogen; also Dr. Allen Miller, Professor at King's College, London, and Assayer to the Mint, a President of the Chemical Society, and for many years Treasurer of the Royal Society; also Sir Lyon Playfair, then Professor of Chemistry at the University of Edinburgh, now a member of Her Majesty's Privy Council and President of the British Association, one to whom we are indebted for his hearty sympathy with the objects of the Institute, and for the unsparing exercise of his efforts and influence on our behalf; also my relative by marriage, Alfred Smee, a pioneer in electro-metallurgy, and inventor of the galvanic battery by which for the third of a century the greater part of the galvano-plastic work of this country has been effected; and lastly, Robert Warington, chemist for many years to the Society of Apothecaries, the founder and first Secretary of the Chemical Society, and a frequent contributor thereto of his characteristically ingenious observations. And not only with the above-named eminent men of science, but with many others also, has it been my fortune to be professionally associated, including, I regretfully have to add among those who have passed away from us, some of the most distinguished original members and warmest friends of the Institute, as Dr. Stenhouse, Sir William Siemens, Professor Way, Dr. Angus Smith, Dr. Voelcker, and Mr. Walter Weldon. Moreover, among the leading men of science of the present day, Sir Frederick Abel, Mr. Crookes, Professor Dewar, Professor Frankland, Mr. Vernon Harcourt, Dr. Tyndall, and Dr. Williamson, are either the holders of definite professional appointments or are otherwise more or less actively engaged in the work of the professional chemist. A profession surely stands in need of no apology which includes and has included in its ranks within such a limited period, such a host of distinguished members.

So far, moreover, from his professional eminence and usefulness being made a matter of reproach to the scientific man, it should constitute rightly a claim to his higher consideration; and far from being accounted a dispa-

ment, should be held as an addition to his scientific standing. In the professions most allied to our own on the one side and on the other, this is well recognised. The physician and the engineer are not merely students of pathology and of mechanics, however important may have been their contributions to pathology and mechanics respectively, but they are the distinguished craftsmen in their respective arts. And whether or not they may have made important contributions to pure science, their rank as eminent scientific men is everywhere and rightly conceded to them. A lucky chance happening to any professional man may indeed bring him to the front, but no succession of lucky chances can ever happen that will of themselves prove adequate to keeping him there. Great qualities are ever necessary to sustain great professional positions; and to be for years one of the foremost in a scientific profession is of itself at least as substantial an evidence of scientific attainment as is the publication of a memoir on some minute point, say of anatomy, or chemistry, or hydrodynamics, for example. And it is so recognised, and very properly recognised, even in quarters where pure science admittedly reigns supreme. Leading engineers and leading physicians and surgeons are every year admitted into the Royal Society, not on account of the importance attaching to any special contributions they may have made to mechanical or pathological science, but mainly because of their eminence in their several professions, in which to be eminent is of itself an evidence of scientific character and of extensive scientific knowledge. It may indeed be taken as beyond question that to obtain and retain a leading position in a scientific profession, needs among other things the possession of high scientific attainments. I say among other things, for without moral qualities in a notable degree, sympathy, endurance, courage, judgment, and good faith, no such professional success is conceivable. Professional eminence is the expression necessarily of scientific ability, but not of scientific ability alone. The self engrossing science of the student has to be humanised by its association with the cares and wants, and the disappointments and successes of an outside world.

(To be continued).

CHEMICAL SOCIETY.

Thursday, November 5th, 1885.

Dr. HUGO MÜLLER, F.R.S., President, in the Chair.

MR. LEONARD DE KONINGH was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Richard Haliburton Adie, Trinity College, Cambridge; James Sabin Adriance, M.A., Williams College, Williamstown, Mass.; Charles Morton Aikman, 12, South Parade, South Kensington; James Anderson, Moone Ponels, Victoria; Edward B. Clark, Rangoon; M. J. R. Dunstan, 24, Sinclair Road, W.; George E. R. Ellis, Haversham Grammar School, Milnthorpe; James Epps, jun., The Homestead, Ross Road, South Norwood; Lazarus Fletcher, 19, Avenue Gardens, Mill Hill Park, Acton, W.; William L. Gadd, 50, Richmond Grove, Manchester; Gilbert Print Girdwood, 28, Beaver Hall Terrace, Montreal, Canada; W. H. Greene, M.D., 3225, Sansom Street, Philadelphia, U.S.A.; Ernest William Harvey, Thomlie Villa, Wishaw, N.B.; George Hirst, 140, Rock Street, Sheffield; Thomas Holgate, Eldon Villa, Batley; Edward E. Howard, Denia Lodge, West Croydon; Mathew Hunter, B.A., Cowside, Settle; George H. Hurst, 11, Cable Street, Salford; John Cecil Husband, Berwick-on-Tweed; Lewis Gordon Paul, Ph.D., Holyrood, Upper Norwood; Leonard Peckitt, 53, South 6th Street, Reading, U.S.A.; Charles Ranken, Stockton Road, Sunderland; Luther R. Scammell, 42, King William Street, Adelaide; James Sim, 77, Dee Street, Aberdeen; Henry

J. Staples, Spondon, Derby; Stephen Stephenson, Llyn-y-mawn, Holywell, Flint; Henry Stocker, Peases West Crook, Durham; Thomas B. Tyson, 50, King Street, Penrith; Henry Collins Williams, 56, Green Lanes, Stoke Newington; Charles F. Young, 43, Manchester Old Road, Middleton.

The following papers were read;—

64. "*The Influence of Silicon on the Properties of Cast-Iron.*" Part II. By THOMAS TURNER, Assoc. R.S.M.

The paper is a continuation of one recently published (*Chem. Soc. Trans.*, 1885, 577).

An account is given of experiments on the relative density, hardness, working qualities, and crushing strength of the metal, and the reason of the variations noticed is discussed.

The relative density was determined both in mass and in small fragments. In the first case, cylinders 3" x 1" were employed, and the turnings from the cylinders were used for a second determination. In iron possessing great tenacity the density was slightly increased, but with less tenacity the density was decreased by the force exerted in turning the metal. The hardness was measured by the weight in grammes necessary to produce a scratch with a cutting diamond. The influence of silicon is shown to be quite regular, the greatest softness being produced by from 2 to 3 per cent. The working qualities are taken from the observation of a skilled workman, and agree very closely with the hardness as before determined.

The crushing strength tests were performed by Prof. Kennedy on cylinders 3" x 0.75", and sketches are given of the fractured specimens. The influence is tolerably regular, and of the kind previously observed, the maximum value being reached with 1 per cent of silicon.

In the following table a summary is given of the chief results:—

Silicon per cent.	Relative density* of cylinders 3" x 1".	Relative density* of turnings from cylinders.	Relative hardness.	Crushing strength. Breaking load per square inch.	
				Pounds.	Tons.
0	7.560	7.719	72	168,700	75.30
0.5	7.510	7.670	52	204,800	91.42
1	7.641	7.630	42	207,300	92.54
2	7.518	7.350	22	135,600 139,000	60.53 62.05
2.5	7.422	7.388	22	172,900	77.18
3	7.258	7.279	22	128,700	57.45
4	7.183	7.218	27	106,900	47.74
5	7.167	7.170	32	103,400	46.16
7.5	7.128	7.138	42	111,000	49.55
10	6.978	6.924	57	76,380	34.10

* Water at 20° C. = 1.

The author draws the following conclusions from these results:—

1. That a suitable small addition of silicon to cast-iron almost entirely free from silicon is capable of producing a considerable improvement in the mechanical properties of the metal.

2. That in these experiments the maximum values are probably reached with the following amount of silicon:—

Crushing strength.. .. .	about 0.80 per cent.
Modulus of elasticity	" 1.00 "
Relative density (in mass)	" 1.00 "
Tensile strength	" 1.80 "
Softness and working qualities	" 2.50 "

3. That when general strength is required the amount of silicon should not vary much from about 1.4 per cent; but that when special softness and fluidity are desirable about 2.5 per cent may be added. Even in the latter case, however, any increase upon 3 per cent must be dangerous.

These conclusions are only strictly true under the circumstances of the author's experiments, but he hopes

shortly to bring forward evidence from independent investigations to support his results.

The cause of these results is discussed. The author is decidedly of the opinion that the production of graphitic carbon is not the only cause of these differences, but that, in addition to the indirect effect owing to the production of grey iron, the suitable addition of silicon has a direct and beneficial influence upon the mechanical properties of the metal.

DISCUSSION.

Dr. WRIGHT inquired whether any experiments had been instituted to determine the influence of silicon on iron containing smaller amounts of carbon. Incidentally he referred to the popular use of the phrase "specific gravity" as being highly objectionable: it was usually difficult to know what was meant. All ambiguity would be avoided if the density, *i.e.*, the weight of a cubic centimetre *in vacuo* at a specified temperature, were stated.

Mr. TURNER said that he had not made any such experiments, but in a subsequent paper he hoped to show that Abel's experiments furnished information on the point in question.

65. "Modifications of Double Sulphates." By SPENCER UMFREVILLE PICKERING, M.A.

The discordant statements as to the heat of dissolution of anhydrous potassium magnesium sulphate are due to the fact that it and its analogues exist in various distinct modifications.

The copper salt, $\text{CuK}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$, on being dehydrated at any temperature between 100° and 130° , leaves a blue powder which dissolves in 800 molecules of water at 18.25° , with an evolution of 9709 cal. When this salt is further heated it loses its colour, becoming generally quite white, and then remains unaltered at any temperature below 250° . The second, or β -modification, dissolves with an evolution of only 6489 cal. at 18.25° . When heated above 250° , the white modification becomes blue again, and suffers no further change on raising the temperature till decomposition sets in at a few degrees above its melting-point. This third or γ -modification dissolves in water with an evolution of 8407 cal. at 18.25° . The three modifications are all perfectly definite and stable compounds, with the slight exception that the white one does not attain a stable condition till about ten days after its preparation. When freshly prepared its heat of dissolution is 330 cal. less than it eventually becomes.

The sum of the heats of dissolution of copper sulphate and potassium sulphate at 18.25° is 9318 cal.; consequently no one of the three modifications consists of the constituent sulphates uncombined.

Potassium magnesium sulphate appears to undergo similar changes, but a dehydration at low temperatures is in this case a matter of difficulty; all specimens prepared between 110° and 155° gave identical numbers for the heat of dissolution at 22.28 , namely, 12,037 cal., corrections being applied where necessary for the small amount of water retained by the specimens. Above 155° the salt changes, dissolving with a smaller heat evolution as the temperature of its preparation is increased, till it reaches a minimum with the fused specimens, being then only 7431 cal. at 22.28 .

The fused salt dissolves with remarkable slowness: this observation leads to the suggestion that the insolubility of anhydrous alum is probably a consequence of some modification in its constitution similar to that experienced by the double magnesian sulphates.

66. "The Relation of Diazobenzene-anilide to Amidoazobenzene." By R. J. FRISWELL and A. G. GREEN.

Amidoazobenzene, an isomer of diazobenzene-anilide, is usually prepared by allowing the latter body to remain in contact with aniline hydrochloride in solution either in aniline, which is the most usual process, or occasionally in alcohol.

The change has been considered by Kekulé and others to be due to a double decomposition; but according to

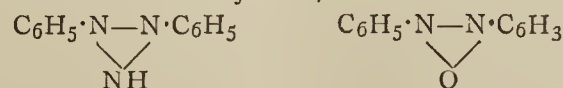
Griess, who discovered both bodies, the anilide is formed at a low temperature by the action of nitrous gas upon aniline, and the amido-compound by the same reagent at a high temperature.

The authors have endeavoured to obtain amidoazobenzene directly from aniline or its salts; but no matter how the experiments were varied as to temperature, acidity, concentration, solvent, order of mixture, and mass of reacting materials, they found that diazobenzene-anilide was formed first, even where, being in the presence of a quantity of aniline salt and in a hot solution, it rapidly changed into the amidoazo-compound.

They have discovered that treatment of diazobenzene-anilide with weak chlorhydric acid causes the change, even in the absence of aniline hydrochloride; but they have also found that both this acid and dilute nitric acid have the power of resolving the anilide into diazobenzene and aniline chlorides; and they have observed that such mixtures by lapse of time combined again into amidoazobenzene, though if the acid were neutralised so as to cause a quick union the anilide was regenerated. From these and other facts detailed in the paper it is inferred that neither is the isomeric change a double decomposition, nor is it due to a coercive action of the acid tending to the development of a basic from an indifferent body, strong acids such as oxalic and sulphuric being unable to produce the change. On the other hand, all the evidence points to time as being absolutely essential for the rearrangement of the molecule. At the same time they are unable at present to account for the remarkable fact that amidoazobenzene can only result from a second stage reaction. It is apparently necessary for the union to take place, so as to form the anilide: this body having been formed, slowly decomposes into diazobenzene and aniline, which then slowly only react, forming amidoazobenzene. If their re-union is hastened the anilide is simply re-formed.

The re-resolution of the anilide and the presence of the products in the solution account for the various decomposition products noticed as accompanying the formation of amidoazobenzene.

A similar isomeric change produced by an acid has been described by Wallach and Belli in the transformation of azoxybenzene into oxyazobenzene by means of sulphuric acid. This change the authors think will probably prove to be analogous to the one now discussed, and, agreeing with V. Meyer's opinion as to the necessity for a symmetrical formula for diazobenzene-anilide, they think that one formed on the type of the azoxybenzene formula to be open to little or no objection, thus:—



67. "An Examination of the Phenol Constituents of Blast-Furnace Tar obtained by the Alexander and McCosh Process at the Gartsherrie Iron Works." By WATSON SMITH, J. F. H. COURTTS, and H. E. BROTHERS. Part I.

By agitating the lighter creosote oils of the blast-furnace tar with an equal bulk of caustic soda solution of 1.09 sp. gr., &c., the authors have obtained 17.5 per cent by volume of crude phenols; while from ordinary gas retort tar, and also from Jameson coke oven oil, they have obtained about 5 per cent. However, by more exhaustive treatment with more concentrated soda solution, 23.1 per cent of phenols was obtained from the blast-furnace oil, and about 8 per cent from the Jameson oil, which seems to be a nearer approach to the shale oil of the paraffin manufacturer; similarly, some 9 or 10 per cent could be obtained from gas retort coal-tar oil.

On fractioning the crude phenols from the blast-furnace oil, only 5.63 per cent by volume distilled over between 180° and 210° , 30.7 per cent between 210° and 240° , and 18 per cent between 260° and 300° . During the distillation of the portions boiling below 300° , and especially of the lower boiling portions, much sulphuretted hydrogen was evolved, and afterwards sulphurous oxide; at the same

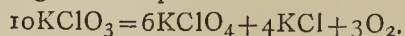
time a considerable amount of sulphur was deposited in the condenser. In fractioning the portion distilling from 300° to the coking-point of the residue, when the latter point was reached both hydrogen cyanide and ammonia were evolved.

The phenols having been separated into groups boiling between certain temperatures, and these fractions purified as far as possible, they were distilled over heated zinc-dust; the hydrocarbons metaxylene, trimethylbenzene (probably pseudocumene), and naphthalene were thus obtained, and from their formation the authors infer the presence of the corresponding phenols in the original oils. Phenol itself was separated in small quantity from the portion distilling between 180° and 210°, metacresol being the chief constituent of this fraction; metaxilenol was one of the most abundant constituents of the portion boiling between 210° and 240°.

Inasmuch as low temperature tars such as that examined contain extremely little phenol, whereas gas retort tars are comparatively rich in this body and also in benzene, and also because other homologous phenols are so abundantly present in blast-furnace tars, it is difficult to accept Schulze's theory as exclusively sufficient to account for so much benzene as is found in gas-retort tars. According to this theory, in the formation of aromatic hydrocarbons by the destructive distillation of coal, phenols are primarily formed, and subsequently suffer disruption at higher temperatures, yielding water and aromatic hydrocarbons. This may be the case to some extent, but it is likely that the synthetic reactions indicated in the theories of Berthelot, Jacobsen, and Anschütz are also largely concerned in the production of the benzene, naphthalene, anthracene, &c.

68. "*The Decomposition of Potassium Chlorate by Heat.*" By FRANK L. TEED, D.Sc., F.C.S.

By heating potassium chlorate till it had lost varying amounts of oxygen, determining that oxygen from the loss in weight, and determining the potassium chloride produced by means of a decinormal silver nitrate solution, using potassium chromate as indicator, the author has come to the conclusion that potassium chlorate decomposes according to the equation—



The equation indicates that for every 74.5 parts of potassium chlorate produced, there should be 24 parts of oxygen evolved; also that when potassium chlorate shall have yielded 7.84 per cent of oxygen, all the chlorate is decomposed and nothing but perchlorate and chloride left.

The equation $2\text{KClO}_3 = \text{KClO}_4 + \text{KCl} + \text{O}_2$, by which the decomposition is ordinarily expressed, requires 32 parts of oxygen to every 74.5 of potassium chlorate, and would not be complete till 13.06 per cent of oxygen had been evolved.

The following are results obtained:—

Amount of KClO_3 taken. Grms.	Oxygen lost, per cent.	Potassium chloride formed, per cent.	Amount of oxygen to 74.5 of KCl .
3.2515	1.66	5.26	23.51
1.592	3.49	10.86	23.94
2.1725	6.00	18.25	24.49
3.956	10.52	27.36	28.65

The last experiment, in which 10.52 per cent of oxygen was evolved, shows a much larger yield of oxygen to the 74.5 parts of potassium chlorate, which is readily explainable by reference to the equation proposed. As mentioned above, the change represented by the equation is finished when 7.84 per cent of oxygen is evolved, and 24.34 per cent potassium chloride is produced.

The remaining 2.68 per cent of oxygen can only be produced by the decomposition of potassium perchlorate in accordance with the equation $\text{KClO}_4 = \text{KCl} + 2\text{O}_2$; from this it follows that 74.5 parts potassium chloride are produced for every 64 of oxygen, and hence that the evolution of 2.68 of oxygen should be accompanied

by the formation of 3.14 of potassium chloride. Therefore, 10.52 of oxygen requires $24.34 + 3.14 = 27.48$ of potassium chloride, a number agreeing fairly well with that found—27.36.

On treating some of the residue from the fourth experiment with sulphuric acid, only the faintest possible indication of a chlorate was obtained.

The author confirms the statement that no perchlorate is formed when potassium chlorate is heated with manganese binoxide, having found in one experiment—the only one made—a ratio of 74.5 of potassium chlorate to 47.15 of oxygen (theory requiring 48), when the amount of oxygen evolved was only 3.38 per cent.

If potassium perchlorate be required in quantity, it would be considerably better to heat the chlorate till only 7.84 per cent than till 13 per cent of oxygen is evolved, as the equation $2\text{KClO}_3 = \text{KClO}_4 + \text{KCl} + \text{O}_2$ indicates a yield of 56.53 per cent of perchlorate; the equation $10\text{KClO}_3 = 6\text{KClO}_4 + 4\text{KCl} + 3\text{O}_2$, a yield of 67.84 per cent.

DISCUSSION.

Dr. ARMSTRONG inquired whether any special method of heating had been adopted, and whether there was any evidence to prove that no perchlorate underwent decomposition in the first three experiments. Granting the correctness of the author's conclusions, the results were of interest, not only because they would enable us to correctly represent the decomposition of potassium chlorate, but also on account of the indication they appeared to afford that the molecular weight of the salt was much higher than is indicated by the formula KClO_3 .

Dr. TEED replied that he had merely used a small flame in effecting the decomposition, and that he had no special proof to offer that the perchlorate had escaped decomposition. It had also occurred to him that his results might be regarded as evidence that potassium chlorate had a higher molecular weight.

69. "*Note on the Refractive Power of Metacinnamene (Metastyrrole).*" By H. G. MADAN, M.A., F.C.S.

A very full investigation into the properties of cinnamene was made by Blyth and Hofmann in 1845 (*Chem. Soc. Memoirs*, ii., 334). They determined its index of refraction to be 1.532 for red rays, and observed its change into a polymer, metacinnamene, by being heated for a short time to a temperature of about 200° in a sealed tube. This latter substance they mention as having a higher refractive index than most organic substances, and as likely to be applicable for various optical purposes.

Scharling (*Annalen*, xcvi., 187) made some further observations on both cinnamene and metacinnamene, and gives as the index of refraction of the latter body (or rather, of much thickened cinnamene) 1.464 for yellow rays; remarking that, though its density is greater than that of cinnamene, its refractive power is lower, contrary to the usual law.

In consequence of a suggestion kindly made by Dr. Perkin, that metacinnamene might be useful as a cement for direct-vision prisms and polarising prisms, the author has thought it worth while to examine the correctness of Scharling's determination of its refractive power.

In the first place, he determined the index of pure cinnamene, b.p. 144°. It was placed in a hollow prism (refracting angle 59° 48'), and the angle of minimum deviation for yellow monochromatic (sodium) light was found to be 40° 48' 5". From these data the index of refraction was found by the usual formula to be 1.541, which sufficiently corresponds with that given by Blyth and Hofmann for what is rather indefinitely called red light.

Some of the cinnamene was then placed in a tube, sealed up, and heated to 194° to 196° in an oil-bath for an hour. This was sufficient to transform it completely into a transparent, colourless, glass-like solid, which in the process of conversion contracted greatly, a hollow more than 1 c.m. deep being formed in its surface, besides another vacuous space lower down in the tube.

When the tube was broken away from the meta-

cinnamene, the latter appeared very like a rod of glass, but slightly flexible and not elastic, soft enough to be cut with a knife, though with difficulty. It became viscous when moderately heated, and seemed to bear sufficient heat to render it semi-fluid without being re-converted into normal cinnamene. Its density was determined to be 1.0563 (the density of pure metacinnamene is stated to be 1.054).

Some of the substance was melted, at as low a temperature as possible, into a hollow prism (brass with sides of plate-glass, selected parallel) having a refracting angle of $51^{\circ} 7'$. The angle of minimum deviation from sodium rays was then determined to be $35^{\circ} 44' 35''$; and hence the index of refraction for rays of wave-length 0.000588 m.m. is 1.593. This is the mean result of two measurements, agreeing to the third decimal place.

The author is unable to account for the discrepancy between this value and the one given by Scharling, viz., 1.464 for what are rather indefinitely called "yellow rays." His specimen of metacinnamene probably contained unaltered cinnamene, but the index is even lower than that of the latter substance. The presumption is in favour of a higher refractive power for a denser polymer.

At the next meeting, on November 19th, there will be a Ballot for the election of Fellows, and the following papers will be read:—

"Aluminium Alcohols. Part III. Aluminium Orthocresylate and its Products of Decomposition by Heat." By Dr. Gladstone and Mr. Tribe.

"Notes on the Constitution of Hydrated and Double Salts." By S. U. Pickering.

"On some Vanadium Compounds." By J. T. Brierley.

CORRESPONDENCE.

SUUM CUIQUE!

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xlviii., p. 56, in a communication headed "Fast-Red or Rocceline," and signed "Aequum et Bonum," I mentioned that, according to chemical literature, α -naphthylamine-sulphonic acids could easily be produced with ordinary concentrated sulphuric acid. Therefore I am very much surprised to read in the *Dyer and Calico Printer* for October 15th, 1885, the following:—"The ways of converting α -naphthylamine into sulphonaphthylamine were well known many years since, but this conversion was only produced by means of fuming sulphuric acid, and Levinstein and Co. were the first to replace this very expensive agent by common vitriol as far back as 1831." Allow me, however, to state that Nevile and Winther published in the *Berichte* of the German Chemical Society, October 18, 1880, No. 16, p. 1948, under the heading "Ueber aromatische Amidosulfosäuren," that naphthylamine sulphonic acid and other amido sulphonic acids of the aromatic group can be easily produced by the use of definite quantities of common concentrated sulphuric acid. In the paper referred to full particulars as to quantities and temperatures are given. And consequently Nevile and Winther have the priority in replacing fuming sulphuric acid by common vitriol.—I am, &c.,

Dr. ALFRED WOLF.

Middlesbrough, Nov. 5, 1885.

SULPHOVINATES.

To the Editor of the Chemical News.

SIR.—Some years ago I published in the CHEMICAL NEWS a few observations on the preparation of sulphovinates. It will be remembered by many of your readers that sulpho-

vinate of soda was recommended by Dr. Rabuteau and others as an elegant substitute for sulphate of soda in pharmacy. It has since been discovered that these compounds are very unstable and quite unfit for medical use. The sulphovinate of soda becomes transformed in time into bisulphate of soda, which would act more or less as a poison with the doses in which the sulphovinate was prescribed, and some fine transparent crystals of sulphovinate of baryta prepared in my laboratory three years ago have become quite opaque and changed into sulphate of baryta.—I am &c.,

T. L. PHIPSON.

Laboratory of Analytical Chemistry,
Putney, S.W., Nov. 4, 1885.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 17. October 26, 1885.

Direct Fixation of Free Atmospheric Nitrogen by certain Clayey Soils.—M. Berthelot.—The nitrogenous compounds which are engaged in the maintenance of life pass through a continual cycle of transformations, during which some portion of their nitrogen incessantly returns to the elementary state. There must therefore, exist inverse reactions capable of fixing atmospheric nitrogen. The only action of this kind known until recently, the formation of nitric acid by the electric spark, is palpably insufficient. The nitric acid thus formed annually in the air of our climate is 385 grms. per hectare, whilst there are needed 50 to 60 kilos. per hectare to furnish the nitrogen removed by the annual products of a hectare of meadow or of forest. The spark forms also ammonium nitrite by acting upon moist nitrogen, but the quantity is less than that of the former. The theory of the circulation of ammonia between the air, the sea, and the vegetable mould proposed by M. Schlæsing still leaves its origin unexplained. It was once thought that plants possessed the power of directly assimilating free nitrogen; but after prolonged controversies and a multitude of experiments the best modern authorities reject this hypothesis. The fixation of nitrogen by the nascent hydrogen evolved from humic bodies on decomposition has not been demonstrated. Some years ago the author established the existence of a new and unexpected cause of the direct fixation of free nitrogen upon the proximate principles of plants: that is atmospheric electricity, acting not by those sudden discharges and violent sparks which form nitric acid and ammonium nitrite during storms, but gradually producing complex nitrogenous compounds by a slow, continuous action, by reason of the feeble tensions which exist at all times and in all places upon the surface of the globe. In investigating this reaction M. Berthelot has discovered another condition—perhaps more general—of the direct fixation of atmospheric nitrogen, the silent but incessant action of clayey soils and of the microscopic organisms which they contain. The author has worked during two years at the Station of Agricultural Chemistry at Meudon, and after five hundred experiments he finds himself warranted in concluding that the argillaceous earths studied, sands, and kaolins possess the property of slowly fixing free atmospheric nitrogen. This aptitude is independent of nitrification as well as of the condensation of ammonia. It is due to the action of certain living organisms. It is not manifested in winter, but especially during the season of activity of vegetation. A temperature of 100° destroys it. It is exerted as well in a closed vessel as in contact with the atmosphere; as well in the open air on the summit of a tower as under

cover, close to a soil covered with vegetation or in a shut-up room in the interior of a building. It takes place both in the dark and in the light, though more actively in the second case.

Experiments on the Transmission of Motive Power by Electricity, between Paris and Creil.—M. Marcel Deprez.—The author has transmitted 40-horse power to a distance of 56 kilometres, 50 per cent of the original power being utilised.

New Process for Producing Hydrogen Gas.—MM. F. Hembert and Henry.—Superheated steam is driven upon incandescent coke in a first retort heated to redness. The products are hydrogen and carbon monoxide in equal volumes. These gases are passed into a second retort also heated to redness and containing refractory bodies. Jets of steam, superheated to the point of dissociation, enter this retort, the result being carbon dioxide and a double volume of hydrogen. The yield is 3200 cubic metres of hydrogen per ton of coke, and the cost price 0·015 franc per cubic metre.

New Neutral Magnesium Carbonate.—R. Engel.—The author has obtained an anhydrous magnesium carbonate absolutely different from that of De Senarmont and from the natural carbonate, and which is more soluble than the hydrated carbonates hitherto known.

Volatility of Mixed Organic Compounds.—Louis Henry.—This memoir does not admit of useful abstraction.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Waste Products.—Could any of your readers mention any waste products or by-products containing silica and iron with a small quantity of alumina.—STAGNATION.

MEETINGS FOR THE WEEK.

THURSDAY 19th.—Chemical, 8. "Aluminium Alcohols. (Part III.) Aluminium Ortho-cresylate and its Products of decomposition," by Dr. J. H. Gladstone and Mr. Tribe. "Notes on the Constitution of Hydrated and Double Salts," by S. U. Pickering. "On some Vanadium Compounds," by J. T. Brierly. Ballot for the Election of Fellows.

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THE CHEMICAL NEWS.

VOL. LII. No. 1356.

ON THE MOLECULAR WEIGHTS OF LIQUIDS AND SOLIDS.

EVIDENCE DEDUCIBLE FROM THE STUDY OF SALTS.*

By SPENCER UMFREVILLE PICKERING, M.A

(Concluded from p. 240.)

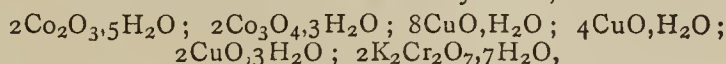
4. Experiments on Hydration, Dehydration, Vapour Tension, &c.

MANY statements may be found of hydrated salts, when heated at certain temperatures, leaving a lower hydrate in which the proportion of water would necessitate a doubling or trebling of the usually accepted formulæ. Such statements, however, must be accepted with the greatest caution. In some cases, such as copper sulphate, a certain number of molecules of water are expelled at 100° C., and the remaining one or ones only at a considerably higher temperature; but even with magnesium sulphate, which is taken as a typical member of this group, the line of demarcation between the hydrates is so ill-defined that sulphate may apparently remain constant in weight at 100° and higher temperatures, but a slight rise of temperature causes a further loss, and the limits throughout which the monohydrate may be obtained without further decomposition is only about 10°, from 150° to 160° C., while above this temperature the last molecule is gradually expelled, though its expulsion cannot be completed below 250°. In this case, and probably in most other cases, the amount of water retained depends so largely on the tension of vapour in the atmosphere that simple heating in an ordinary air-bath gives no reliable results. Before we can accept the existence of any new hydrate as having been obtained by such a process, it should be proved that its existence was permanent throughout a sufficiently wide variation of conditions. Such a statement as that of a substance losing four-fifths of its water at t° , and the remaining one-fifth at t'° , is of no value in proving that the number of water molecules present is divisible by 5, unless it is also shown that no change whatever takes place between t and t' .

One good instance, in which the hydrates formed gave conclusive evidence as to the molecular weight of a substance, was brought before the Chemical Society by the author (*Chem. Soc. Trans.*, 1883, 182). The analysis of basic ferric sulphate would lead to a minimum molecular weight of 400, represented by the formula $2\text{Fe}_2\text{O}_3 \cdot \text{SO}_3$: this substance, however, combines in various proportions with water, and by heating it in dry and moist air as many as fourteen different hydrates were obtained: of these only four could be represented by the above formula, while the remaining ten necessitated a molecular weight three times as great, the salt being represented by the formula $\text{Fe}_2(\text{SO}_4)_3 \cdot 5\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$,—i.e., the normal salt combined with a certain number of molecules of the metallic oxide and water; at the same time the fact that none of these hydrates necessitated any greater molecular weight rendered the probability in favour of its not being greater at least than 95,000 : 1.

Experiments somewhat similar to these have been made by Cross (*Journ. Chem. Soc. Trans.*, 1879, 796; *CHEMICAL NEWS*, xlv., 101, 209; xlvii., 239; xlix., 220). various salts and oxides having been exposed to air saturated with moisture. The amount of water which the substance ab-

sorbed was found to be definite, and in molecular proportion to the substance taken. The hydrates,—



which would involve a multiplication of the ordinary molecular weights, were amongst those obtained; but at present the details of most of the experiments, as well as the conclusions deducible from them, have not been published, so that it would be premature to discuss what weight should be attached to them.

Hannay (*Chem. Soc. Journ.*, 1877, ii., 381, and 1879, *Trans.*, 456) has examined the process of dehydration of a salt by a different method: he determined the rate of the loss of water, any sudden change in that rate being considered as indicative of the formation of some fresh hydrate. Five single salts and eight double salts were examined: out of these two only gave indications of the existence of any hydrate which would necessitate doubling the molecular weights usually assigned to them. These hydrates were—

$2\text{CaSO}_4 \cdot 3\text{H}_2\text{O}$, $2\text{CaSO}_4 \cdot \text{H}_2\text{O}$, and $2(\text{Na}_2\text{SO}_4 \cdot \text{K}_2\text{CrO}_4) \cdot \text{H}_2\text{O}$ respectively; but a careful examination of his results fails to carry conviction with it, and the existence of any sudden breaks in the rate of loss may well be doubted in these particular instances.*

Ramsay (*Chem. Soc. Journ.*, 1877, ii., 395) examined the hydrates of aluminium, iron, and copper by the same method as that employed by Hannay, but without obtaining any evidence as to the existence of new hydrates which would involve any alteration in the accepted molecular weights, and indeed in one case only ($\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$) did he obtain any evidence as to the existence of definite hydrates at all, and that evidence was by no means unquestionable. With lead oxide the two hydrates $2\text{PbO} \cdot \text{H}_2\text{O}$ and $3\text{PbO} \cdot \text{H}_2\text{O}$ (which had previously been noticed by others) were obtained, but in this case no details were given which would even prove that when weighed they had attained a state of equilibrium, and still less that that equilibrium was stable.

Various experiments on the vapour tension of hydrated salts have been directed towards the investigation of new hydrates, any sudden change in the vapour tension after the loss of a certain amount of water indicating the existence of a definite hydrate. Sodium phosphate, carbonate, sulphate, and borate, together with barium hydrate, calcium chloride, and other salts, have been thus examined, but only in one case, that of borax, were hydrates indicated inconsistent with the lowest empirical formulæ of the salts, thus bearing out the evidence derived from other sources. (See Debray, *Comptes Rendus*, 66, 194; Lescaeur, *ibid.*, 92, 1158, and 96, 1578; Müller-Erzbach, *Ann. Phys. Chem.* [2], 23, 607; Etard, *Comptes Rendus*, 98, 993, 1276, 1432; Wiedemann, *Pogg. Ann. Jubelband*, 1874, 474; Nauman. *Bee.*, 1874, 1573; Precht u. Kraut, *Liebig's Ann.*, 178, 129.)

The dilation of salts when heated has been studied by Wiedemann (*Poggendorff's Annalen*, 18, 561), and, among the salts which he examined, hydrated magnesium and also zinc sulphate were found to exhibit sudden changes in the rate of their expansion. These anomalies he attributes to their existence in different modifications. It is quite possible, however, that such modifications may be due to the different arrangement of the many water molecules present in the salts, and not to changes in their molecular weights.

All the evidence to which I have hitherto alluded refers exclusively to salts in the solid state; besides calorimetric evidence, which will be treated separately, there are a

* Hannay examined three of the double sulphates, of the type $\text{MgSO}_4 \cdot \text{ZnSO}_4 \cdot 14\text{H}_2\text{O}$, and states that their behaviour is entirely different to that which a mixture of the two salts exhibits; from this it would follow that there could be no doubt as to these double salts being in reality well-defined compounds. The statements in his second paper, however, are quite irreconcilable with those in his first paper, and are also at variance with the author's observations on these salt

* A Paper read before Section B, British Association, Aberdeen Meeting.

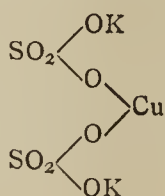
few experiments which may be brought to bear on the state of hydration of salt molecules in the dissolved condition.

Wüllner (*Pogg. Ann.*, 103, 529; 110, 564) showed that, with certain anhydrous salts, the extent to which the boiling-point of their solutions is raised is proportional to the quantity of salt dissolved, whereas in other cases, and with hydrated salts, such a proportionality can be observed only when some of the water is regarded as forming an integral part of the substance,—i. e., that a hydrate of the salt exists in the solution. Rüdorff (*Pogg. Ann.*, 114, 63; 116, 55; 122, 337) established a similar conclusion as to the lowering of the freezing-point of such solutions, and De Coppet (*Ann. Chim. Phys.* [4], 23, 366; 25, 550; 26, 98) as to the lowering of the temperature at which the solution attains its maximum density. By measuring the raising of the one point and the lowering of the other two these physicists have been enabled to deduce the nature of the hydrate which exists in various solutions at these temperatures. Out of some thirty-eight substances thus examined one hydrate only, namely, $2\text{NaOH} \cdot 3\text{H}_2\text{O}$, was found to exist which could not be formulated without doubling the accepted molecular weight.

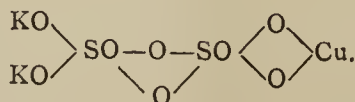
Evidence deduced from Calorimetric Experiments.

I have elsewhere (*ℳ. Chem. Soc. Trans.*, 1884, 686) had occasion to allude to some work on the double sulphates of the magnesian and alkali metals, which, although complete, has not yet been published. It has been ascertained that anhydrous copper-potassium sulphate (and probably all the many double salts belonging to the same class), exist in three distinct modifications; two of them are blue, and one white, the transformation of one modification into the other being effected by the simple application of heat, and between certain moderately wide ranges of temperature each of these is perfectly stable. Their existence was recognised and established by the very different amounts of heat which they evolve when dissolved in water. At 18°C ., for instance, these quantities are 9720, 6150, and 8400 cal. respectively, while their specific heats show a similar difference, being about 56, 51, and 59, and point incontestably to the same conclusion.

Now the first of these, from considerations which it is not possible to enter into at the present moment, is in all probability a so-called molecular compound represented by the formula $\text{CuSO}_4 \cdot \text{K}_2\text{SO}_4$, while to the other two we have no difficulty in assigning such atomic constitutions as—



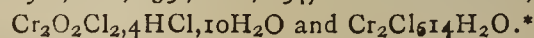
and—



Thus here, where various modifications of a compound do exist, we need have no recourse to polymerism in order to explain their existence: indeed the case may be stated in a somewhat stronger light, for the number of modifications which exist exactly corresponds to the number (unless we indulge in fantastic and improbable atomic arrangements) which may be ascribed to the general formula $\text{CuK}_2(\text{SO}_4)_2$.

Another instance of a similar character is afforded by the soluble chlorides and sulphates of chromium. The two modifications which exist of each of these behave differently towards a reagent which will precipitate the acid radicle present in them. With the sulphates discovered by Loewel (*Ann. Chim. Phys.* [3], 14, 244), Favre

and Valson found that one-third of the acid was precipitated with an evolution of 4900 cals., whereas the other two thirds on precipitation evolved only 146 and 58 cals. respectively, and hence proposed the formula $(\text{Cr}_2[\text{SO}_4]_2)\text{SO}_4$ for this modification, reserving $\text{Cr}_2(\text{SO}_4)_3$ for those which behaved normally (*Comptes Rendus*, 74, 1023), formulæ similar to those adopted by Peligot (*Ann. Chim. Phys.*, xiv., 239; xvi., 294) for the chlorides,—



The possibility of adopting such formulæ obviates the necessity of having recourse to polymerism, and, whether these formulæ are admissible or not, it is impossible to see how polymerism could explain the facts here observed.

In very few cases is there any difficulty in explaining the existence of different modifications of a salt except by polymerism. I have shown, however (*ℳ. Chem. Soc. Trans.*, 1884, 686), that anhydrous sodium sulphate, when heated to 200°C . and higher temperatures, passes into a modification which dissolves (at 20°C . in 400 H_2O) with an evolution of heat 700 cals. in excess of the sulphate prepared at lower temperatures. Tilden, in a paper recently communicated to the Royal Society, has confirmed this observation; and, by combining his results with mine, it may be seen that the difference between the heat of dissolution of these two modifications diminishes as the temperature rises, and that, consequently, their specific heats in the solid state must be different, thus emphasizing the distinction between them. It would appear that polymerism only can explain such differences. Sodium sulphate, however, is undoubtedly a somewhat peculiar and exceptional salt, and its behaviour under heat must not lead us to expect a similar behaviour in the case of its congeners. Potassium, lithium, magnesium, and copper sulphates have all been examined in a similar manner without giving any evidence of their existing in more than one modification (*ℳ. Chem. Soc. Trans.*, 1885, 98 and 103).

Another salt which appears to resemble sodium sulphate in this respect is mercury iodide. Berthelot (*Comptes Rendus*, 93, 870) found that the conversion of the yellow into the red modification is accompanied by an evolution of 3000 cals. Certain anomalies as to the heat evolution during the precipitation of silver iodide led him to conclude that this salt also existed in two different forms: the heat reactions of these two forms, however, were so nearly identical that no very certain evidence could be obtained on the subject.

Calorimetric methods would, however, probably fail to help us in detecting such polymers in most cases. The heat of combination of two molecules belonging to the same class, but not to the same division of that class, is generally small: thus $\text{CuSO}_4 + \text{K}_2\text{SO}_4 - 571$ cals. only; it would probably be still less between two molecules more nearly resembling each other, such as MgSO_4 and CuSO_4 , and quite insignificant between two identical molecules: it may therefore well be doubted whether the calorimeter would in such cases yield sufficiently delicate results to show any distinction between two polymers such as $x\text{MgSO}_4$ and $y\text{MgSO}_4$.

It is true that the heat reactions of the polymers which are met with in the domain of organic chemistry would distinguish them as effectually as do the chemical reactions by which they are formed and decomposed, or their physical properties in general (*Berth. Méc. Chim.*, i., 547), but it must be remembered that the polymers into the existence of which we are now inquiring are very different from those bodies which are generally referred to in that term, and might advantageously be designated by some different name. Two polymers, in the ordinary sense of the word, have, as a rule, a totally different atomic constitution, and bear no relation to each other except in the accidental circumstance of yielding the same numbers on analysis, whereas we are at present discussing the possibility of

* The anhydrous salts form in all probability third modifications.

the smallest particle of some particular substance being constituted in reality of several of those groups which have generally been regarded as molecules, or of there being two or more modifications of the *same* substance, differing only in the number of such groups constituting their molecules. The borates, phosphates, &c., mentioned above should, perhaps, be classed with the former rather than with the latter class of polymers.

Thermo-chemistry will probably help us but little in solving this problem, though it may supply us with important information as to the complexity of hydrated molecules, especially when in a state of solution.

Thermo-chemical experiments, no less than considerations drawn from various sources, show that in many cases not only do known hydrates exist in solution, but that higher hydrates, unknown in a solid condition, are also formed when a salt is dissolved in water. So far, however, experiments of a nature sufficiently precise to determine the exact formulæ of these hydrates are wanting, and their coexistence with partially dissociated hydrates may in many cases render it impossible ever to ascertain their exact formulæ.

Thus, by diluting acids of various degrees of hydration with a large quantity of water, Berthelot obtained indications of the existence of the hydrates $\text{HNO}_3, 2\text{H}_2\text{O}$, $\text{HNO}_3, 15\text{H}_2\text{O}$, $\text{HCl}, 6\cdot5\text{H}_2\text{O}$, $\text{HBr}, 4\cdot5\text{H}_2\text{O}$, and $\text{HI}, 4\cdot5\text{H}_2\text{O}$: the existence of the last three he considers *may* be in accordance with the experiments of Roscoe and Dittmar on the ebullition and evaporation of these acids (*Quart. Journ. Chem. Soc.*, xii., 128, and xiii., 156), as well as with certain chemical reactions which are reversed when the concentration of the acids exceed the limits indicated by these proportions, but it would be useless to insist on these formulæ, for, to quote Berthelot's words, "Aussi ne peut on pas préciser d'une manière absolue la composition de ces hydrates d'après la courbe thermique, mais seulement d'une manière approchée." (See *Ann. Chim. Phys.* [5], iv., 446; *Comptes Rendus*, 86, 279: *Méc. Chim.*, i., 517; ii., 149.)

A similar investigation of the alkalies (*Ann. Chim. Phys.*, [5], iv., 531) led to no more definite conclusions as regards the hydrates which they form.

The general conclusion which may be drawn from the various facts which I have had the honour of laying before this Section of the British Association is, that, although in a few isolated cases the molecular weight would appear to be greater than the analytical results necessitate, still, in a vast majority of cases, we have no grounds for multiplying these weights, and have indeed a considerable mass of evidence in favour of adhering to the simplest possible formulæ.

Such a conclusion may at first sight appear to be in opposition to conclusions drawn from other sources. On the one hand, I consider it undeniable that if we succeed in determining the number of replaceable portions of the elements in any compound, we determine, *ex hypothesi*, the number of atoms in the molecule,—that is, the molecular weight: the data at our disposal are at present of the most meagre description, but, such as they are, they seem to point to the simplicity of these molecules. On the other hand, considerations based on the crystalline form, and other physical properties of bodies, force on us the conclusion that liquid and solid molecules are in all probability of a very complicated nature,—certainly more complicated than gaseous molecules. Both these conclusions, I believe, are correct. Because the smallest particle of a substance which enters into a chemical reaction may be simple, I see no reason whatever for concluding that many of these particles—perhaps many hundreds or many thousands of them—may not agglomerate and act in unison as regards certain physical forces. That this agglomerate does not act as a unit towards chemical forces, would simply imply that the force which unites the individuals constituting it is not chemical force, or is chemical force of such a weak nature that, in pre-

sence of the strong chemical agents which we make use of, it is inappreciable. The molecule of the chemist is not necessarily identical with the molecule of the physicist.

ON CERTAIN DIATOMACEOUS DEPOSITS (DIATOMITE) FROM THE PEAT OF ABERDEENSHIRE.*

By W. IVISON MACADAM, F.C.S., F.I.C., &c.,

Lecturer on Chemistry, School of Medicine,
Professor of Chemistry, New Veterinary College, Edinburgh;
Honorary Secretary of the Edinburgh Geological Society; and
Delegate to the Association.

DURING the early months of 1882 my attention was directed by Mr. Hamilton Bell, of the Edinburgh Geological Society, to a white deposit found underlying the peat in certain districts of Aberdeenshire. The same gentleman also placed before me two articles which had appeared in the *Aberdeen Free Press* on the subject. From these articles the information was obtained that the Rev. Geo. Davidson, Minister of Logie-Coldstone, had examined the deposit microscopically, and had found it to consist of large masses of diatoms. To this gentleman and to the Rev. J. G. Michie, Minister of Dinnit, I am indebted for much information on the subject generally, and to the first-named for the very complete list of species I am able to lay before you.

The following are the principal deposits now known to exist in Aberdeenshire:—

1. *Kinnord*.—This deposit extends over the bottom of the Loch of the same name, and also underlies the peat on the west side for some distance. The material is several feet thick.

2. *Black Moss*.—This deposit has been thoroughly proved by the Earl of Aberdeen, to whom a considerable portion of it belongs, and has been found to contain some 800,000 cubic yards, a quantity equivalent to about 150,000 tons weight. The deposit is 20 feet thick at the deepest part. The Black Moss lies about a mile and a half to the north-east of Loch Kinnord.

3. *Ordie Moss*.—This deposit was some sixty acres in extent, but is now exhausted. The moss lies due south of Ordie. The depth of the deposit was not more than 15 inches.

4. *Auchnerran*.—This deposit, which is about half a mile in diameter, occupies the ground stretching between Bhlack and the Morven Hills. It is of considerable depth, but not so pure as the other deposits.

5. *Logie Moss*.—This deposit has not been thoroughly proved, but is about 20 acres in extent. The depth is not known.

6. *Milton*, about half a mile to the north of Auchnerran.—The deposit is of considerable extent, and about 2 feet in depth. The surface-soil has been mostly turned into arable land.

Some smaller deposits are also known, but have not as yet been proved or tested.

The whole of these masses of diatomite lie in a basin which was at one time a large lake, some five miles long, and embracing Lochs Davin and Kinnord. A somewhat curious point in regard to the deposits is that whilst in Loch Kinnord the material is found distributed over the whole lake in considerable quantity, that in Loch Davin hardly any diatoms are to be obtained, either fossil or recent. In Loch Kinnord the deposit is most thick on the side into which the Culbleen Burn flows, and this fact may aid somewhat in the solution of the problem why Loch Davin, lying as it does so close to Loch Kinnord, should not contain diatomaceæ. The Culbleen Burn has its origin in the Culbleen Hills, these being composed of

* A Paper read before Section B, British Association, Aberdeen Meeting.

TABLE A.—ANALYSES OF DIATOMITE (ABERDEENSHIRE).

(After Air-drying and as sent to Market.)

	BLACK MOSS.			ORDIE MOSS.		DRUM MOSS.	KINNORD MOSS.	
	No. 1. Margin.	No. 2. Centre.	No. 3.	No. 1.	No. 2.		No. 1.	No. 2.
Moisture	12'61	10'52	9'92	10'42	10'32	5'41	10'24	7'45
Organic matter	37'99	32'76	25'48	45'30	30'02	4'52	20'08	27'00
Mineral matter	49'40	56'72	64'60	44'28	59'66	90'07	69'68	65'55
	100'00	100'00	100'00	100'00	100'00	100'00	100'00	100'00

TABLE B.—ANALYSES OF DIATOMITE (ABERDEENSHIRE).

Calculated free from Moisture.

Organic matter	43'472	36'613	28'286	50'570	33'586	4'779	22'371	29'173
Mineral matter	56'528	63'387	71'714	49'430	66'414	95'221	77'629	70'827
	100'000	100'000	100'000	100'000	100'000	100'000	100'000	100'000

TABLE C.—ANALYSES OF THE MINERAL PORTION OF DIATOMITE (ABERDEENSHIRE).

I. Soluble in Water—									
Calcic oxide	0'741	0'946	0'841	0'765	0'362	0'943	1'040	1'216	
Magnesian oxide	0'332	0'552	0'548	0'482	0'371	0'456	0'606	0'504	
Potassic oxide	0'076	0'213	0'224	0'187	0'108	0'315	0'327	0'313	0'115
Sodic oxide	0'048								
Sulphuric anhydride ..	0'168	0'374	0'289	0'253	0'242	0'832	0'733	0'753	
Chlorine	trace	trace	trace	trace	trace	0'171	trace	trace	
II. Soluble in Acid (HCl)—									
Ferric oxide	1'903	1'343	2'885	6'565	2'273	1'459	4'120	5'504	
Aluminic oxide	0'236	0'429	0'407	0'201	0'154	1'104	1'854	2'101	
Calcic oxide	2'737	2'692	2'484	2'897	0'782	2'378	0'998	2'939	
Magnesian oxide	0'670	0'741	0'646	0'632	0'326	0'854	0'205	0'635	
Alkalies	0'268	0'187	0'215	0'194	0'103	0'358	0'143	0'271	
Phosphoric anhydride ..	—	—	—	—	—	—	—	—	
Soluble silica	0'541	0'621	0'437	0'441	0'281	1'121	0'921	1'125	
III. Silicates, decomposed by hydric fluoride—									
Ferric oxide	0'142	0'089	0'156	0'166	0'579	4'853	0'142	0'232	
Aluminic oxide	0'535	0'202	0'342	0'383	0'463	4'404	0'303	1'106	
Calcic oxide	0'114	0'132	0'127	0'155	0'432	2'136	0'058	0'184	
Magnesian oxide, &c. ..	0'022	0'071	0'095	0'102	0'138	0'632	0'014	0'042	
IV. Silica (mostly diatoms) ..	91'067	91'012	87'962	86'125	93'075	77'498	88'232	82'986	
	99'600	99'704	99'658	99'548	99'689	99'514	99'696	100'026	

a coarse granitic rock much weathered. The stream which feeds Loch Davin has its rise on hills composed of a compact horn-blende, and the water flowing from which necessarily contains little or no soluble silica, such being essential to the diatom to enable it to build up its skeleton, and which it finds in a condition easily assimilated in the granite-born waters of Culbleen.

As already stated, all the Aberdeen localities may be said to belong to the same watershed, and in fact to the same sheet of water. That all of the deposits were formed under water there can be no doubt, as in one and all of the samples the binding material is found to consist of varieties of Sphagnum, Equisetaceæ, and other water-loving plants, the more common species determined being *Equisetum limosum* and *fluviatile*, *Phragmites communis*, &c. Where the deposition has taken place in deeper water the material becomes of less value from the difficulty of "winning" the substance. Where the bog has become consolidated, the overlying material consists of peat sometimes of very considerable thickness, as in the case of the Black Moss, where from 10 to 14 feet of good fuel was removed. In fact, the preservation of this diatomite to our day entirely depends, in such cases as the Black Moss, on this superficial layer of common brown peat. The presence of a more or less siliceous or earthy deposit underlying the peat has been long known, and, in fact, becomes the point where the peat-cutter ceases to obtain fuel of a valuable description. In all mosses this

layer exists, but from the small amount of heat derived from the material, as well as the large proportion of ash left after calcination, it is never cut by the crofters. In the fact of the overlying peat having been previously cut for fuel we find the reason why the Black Moss deposit can be so readily, and at the same time cheaply, cut and sent to market. The binding material obtained in the water-plants allows of the substance being cut in a similar manner to peat, and also air-dried, whilst the resulting solid can be conveyed to market in blocks.

The material when ready for market, that is, when air-dried, has lost the dark brown colour of the wet substance, and become a light fallow-grey block of low specific gravity and great porosity, six cubic yards of the air-dried solid being necessary to weigh a ton.

The chemical analyses (Table A) of the various samples show that about 10 per cent of moisture is still retained by the substance after the preliminary air-drying, and that the water plants, &c., have yielded to the mass a proportion of organic vegetable matter varying according to the position and locality from which the sample was obtained, from 4½ per cent to 45½ per cent, the average being about 25 per cent. The remaining inorganic solids, amounting to from 90 per cent to 44 per cent, or say to an average of 60 per cent, consists of almost pure diatomaceæ. In Drum deposit alone do we find any large proportion of silica crystals.

In Table B are given the relative proportions of or-

ganic to inorganic materials; in other words, of vegetable to siliceous (diatomaceous) substance. The proportions being free from water of moisture can be more readily compared one with another, and the value of the various localities as diatomite producers noted.

The principal uses to which this diatomite has been as yet put are in the manufacture of dynamite (where it is an absorbent), for ultramarine (where it is chemically combined), for non-combustible paints, for boiler compositions, and for silver-plate soaps, &c. For all of these purposes the material is first calcined, and then the resulting white ash may be submitted to the various processes. The detailed analyses of the inorganic or calcined mass show how very pure the material is, and how extremely free from foreign admixture. For most of the purposes mentioned above the presence of a little foreign matter may not be damaging, but for ultramarine manufacture only the most pure silica is available, even a minute quantity of iron spoiling the pure blues or greens of that tint. No more pure variety of silica, or one in a more fine state of division, and therefore more readily acted upon, is available.

For dynamite a very large quantity (some hundreds of tons) was cut and sold to Messrs. Nobel last season, and a great future was looked forward to; but, alas! the industry was doomed, for the powerful dynamite had to make way to a still greater giant in blasting-gelatin, and what had promised a great future to Aberdeenshire fell from its lofty position as an explosive, and the interests of this country fell with it. This season I learn that not a single ton has been cut from the mosses.*

Whilst Aberdeenshire can at present claim the greatest known extent of diatomite, there are very considerable masses in other parts of Scotland, such as Aros, in Mull; Sutherlandshire; Strathcur, in Argyllshire; Gress, in Lews; Campbeltown, &c. Some of these deposits are of considerable extent, and, provided new sources of output are found, no difficulty in the supply need be feared.

In the *Proceedings of the Geological Society of Edinburgh*, vol. iv., Part 3, I have already published a list of the species of diatomaceæ found in the deposits of Aberdeenshire by the Rev. Geo. Davidson, of Logie-Coldstone, to whom, as to many others, I am deeply indebted for much valuable information. In the same volume will be found a list of the diatomaceæ of the Gress deposit by Mr. E. W. Burgess, to whom I tender my thanks.

The relative absorptive values of these diatomites as against kieselguhr is as follows:—

Kieselguhr (Lauenberg)	316
Sutherland diatomite	381
Aberdeenshire	639

On taking kieselguhr as 1, the Sutherland deposit is equal to 1.2, and the Aberdeenshire material 2.02.

NEW RESEARCHES ON THE COMPOUNDS OF DIDYMIUM.†

By P. T. CLEVE.

(Continued from p. 227)

Iodate of Didymium, $\text{Di}_3\text{IO}_3 + 6\text{H}_2\text{O}$ ($2\text{H}_2\text{O}$, dried at 100°).

Iodic acid gives with the salts of didymium an amorphous, bulky, and faintly violet precipitate which, after having been dried between paper, loses on heating to 100° 9.90 per cent H_2O (calc. 9.29). A portion of the salt, dried at 100° , was analysed.

I. 0.5056 grm. was dissolved in water containing sulphurous acid, nitrate of silver added, and the didymium

precipitated after filtering from the AgI, 0.5041 grm. AgI and 0.1240 grm. Di_2O_3 were thus obtained.

II. 0.7400 grm. gave 0.7169 grm. AgI and 0.1840 grm. Di_2O_3 .

In per cent—

			Calculated.	
Di_2O_3 .	24.53	24.86	166	23.61
I_2O_5 ..	70.85	68.85	501	71.27
H_2O ..	—	—	36	—
			703	

As the quantity of didymium exceeds the calculated amount, it looks as if the salt were decomposed by washing with water.

Periodate of Didymium, $\text{DiIO}_5 + 4\text{H}_2\text{O}$.

A solution of periodic acid gives with the salts of didymium a gelatinous precipitate which, when left in contact with an excess of periodic acid, is changed into a heavy powder, consisting of microscopic needles, exactly resembling the corresponding salt of samarium. The salt loses no water at 100° .

0.6058 grm. was reduced with sulphurous acid and gave with nitrate of silver 0.3365 grm. AgI.

0.4307 grm. was evaporated with water, containing sulphurous acid, and gave 0.2907 grm. Di_2SO_4 .

In per cent—

			Calculated.	
Di_2O_3	39.18	166	39.43	
I_2O_7	43.26	183	43.47	
H_2O	—	72	—	
		421		

Specific gravity—

0.9296 grm., small crystals, $t^\circ 21.2^\circ$, sp. gr. 3.755

0.5923 " " " " 3.761

Mean of both determinations, 3.758.

Molecular volume, 112.

Sulphate of Didymium.

I. Anhydrous salt, Di_2SO_4 .

Specific gravity—

1.6536 grm., temp. 18.3° , sp. gr. 3.672

1.8473 " " " " 3.662

Mean of both determinations, 3.667.

Molecular volume, $\frac{572}{3.667} = 156$.

2. $\text{Di}_2\text{SO}_4 + 8\text{H}_2\text{O}$.

Specific gravity—

2.1520 grm., temp. 16° , sp. gr. 2.831

2.8886 " " " " 2.827

2.9228 " " " " 2.828

Mean of the three determinations, 2.829.

Molecular volume, 253.1.

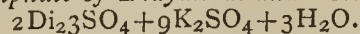
3. $\text{Di}_2\text{SO}_4 + 5\text{H}_2\text{O}$. This sulphate is obtained by evaporation of solutions at nearly 100° and separates in red needles, which very rapidly take up water at the ordinary temperature, so that it is extremely difficult to get it with exactly $5\text{H}_2\text{O}$. This is certainly the reason why Marignac assigns to it $6\text{H}_2\text{O}$.

1.1775 grm. lost on heating 0.1688 grm. H_2O .

In per cent, 14.34. Calc., 13.60.

Six mol. H_2O corresponds to 15.88 per cent.

Sulphate of Didymium and Potassium.



On adding to a cold solution of the acetate of didymium an excess of sulphate of potassium, a red, scarcely crystalline, heavy powder separates. It was pressed between filter-paper and analysed.

* Since the above was written orders have been received for several hundreds of tons of the diatomite.

† Presented to the Royal Society of Sciences of Upsala, March 20, 1885.

1.3974 grm. lost on heating 0.0267 grm. H_2O and gave 0.3408 grm. Di_2O_3 and 0.7905 grm. K_2SO_4

In per cent—

			Calculated.	
Di_2O_3	24.39		664.0	24.01
K_2O	30.59		847.8	30.65
SO_3	—		1200.0	—
H_2O	1.91		54.0	1.95
			2765.8	

Sulphate of Didymium and Ammonium.
 $\text{DiNH}_4\text{SO}_4 + 4\text{H}_2\text{O}$.

From the mixed solutions of the simple salts small red crystals are obtained. These crystals are soluble with difficulty, and are not altered by exposure to the air. They lose $3\text{H}_2\text{O}$ at 100° (found 12.47 per cent, calc. 12.73).

0.5095 grm. lost by heating to 220° 0.0937 grm. H_2O and gave 0.3799 grm. Di_2SO_4 .

0.864 grm. gave 0.3408 grm. Di_2O_3 and 0.937 grm. BaSO_4 .

0.836 grm. gave 0.335 grm. Di_2O_3 and 0.908 grm. BaSO_4 .

In per cent—

			Calculated.	
Di_2O_3	39.41	39.44	40.07	166
$(\text{NH}_4)_2\text{O}$	—	—	—	26
SO_3	—	37.24	37.29	160
H_2O	16.75	—	—	72
			424	

Specific gravity—

I. Crystallised salt, small crystals.

0.8296 grm., $t^\circ 15$, sp. gr. 2.575.

1.1825 " " " 2.575.

Molecular volume, 164.7.

II. Anhydrous salt.

1.3008 grm., $t^\circ 15^\circ$ sp. gr. 3.086

1.0362 " " " 3.075

Mean of both determinations, 3.080.

Molecular volume, 114.3.

Crystalline form monosymmetric. Crystals small, developed parallel to $\infty P \infty$.

$a : b : c = 0.341727 : 1.046170 ; \beta = 84^\circ 31' 56''$.

Forms: $\infty P ; \infty P \infty, P \infty, 2P \infty, \infty P \infty$. (C. Morton.)

Selenate of Didymium, $\text{Di}_3\text{SeO}_4 + 5\text{H}_2\text{O}$.

On evaporating the solution of oxide of didymium in selenic acid on a water-bath, this salt is deposited in red four sided prisms.

0.8271 grm. lost on heating to 240° 0.0896 grm. H_2O , and gave on ignition to a white heat 0.3432 grm. Di_2O_3 .

1.5185 grms. gave 0.1651 grm. H_2O and 0.6333 grm. Di_2O_3 .

3.7442 grms. was heated to 230° , and gave 0.4168 grm. H_2O .

In per cent—

			Calculated.	
Di_2O_3	41.49	41.71	—	332
SeO_2	(47.68)	(47.42)	—	381
H_2O	10.83	10.87	11.13	90
			803	100.00

Specific gravity of the crystallised salt—

1.9203 grms., crystals, $t^\circ 18.3^\circ$, sp. gr. 3.685

1.4336 " " " $t^\circ 15^\circ$, " 3.677

Mean of both determinations, 3.681.

Molecular volume, 218.1.

By evaporation of the solution at ordinary temperature rounded masses of very fine needles are obtained, which

could not be perfectly freed from the mother-liquor. According to my former researches this salt seems to contain $10\text{H}_2\text{O}$. I have not been able to get a selenate with $8\text{H}_2\text{O}$ from the pure oxide of didymium.

Anhydrous salt, Di_2SeO_4 .

Specific gravity—

1.7907 grms., $t^\circ 12.5^\circ$	Sp. gr. 4.416
1.4309 " "	" 4.430
1.1772 " $t^\circ 18^\circ$	" 4.461
1.3935 " "	" 4.442

Mean of the four determinations, 4.442.

Molecular volume, 160.5.

Selenate of Didymium and Potassium,
 $\text{DiK}_2\text{SeO}_4 + 5\text{H}_2\text{O}$.

By evaporating the mixed solutions of the simple salts at the ordinary temperature (about 17°) large and well-formed red prisms, easily soluble in water, are obtained. The salt loses at 100° 14.16 per cent H_2O , or $4\frac{1}{2}$ mols. (cal. 14.50).

0.4410 grm. was boiled with HCl and precipitated with SO_2 . The precipitated selenium weighed 0.1237 grm. The filtrate was evaporated and precipitated with ammonia, and the didymium-hydroxide re-dissolved and precipitated with oxalic acid. From the filtrate from the hydroxide 0.1977 grm. K_2PtCl_6 was obtained. The oxalate of didymium left on ignition 0.1308 grm. Di_2O_3 .

0.4316 grm. gave in the same manner 0.1204 grm. Se , 0.1278 grm. Di_2O_3 , and 0.1997 grm. K_2PtCl_6 .

In per cent.

			Calculated.	
Di_2O_3	29.68	29.61	166.0	29.80
K_2O	8.69	8.96	47.1	8.46
SeO_3	45.09	44.85	254.0	45.59
H_2O	(16.54)	(16.58)	90.0	16.15
			557.1	100.00

Specific gravity—

0.5877 grm., large crystals, $t^\circ 13$, sp. gr. 3.174

0.6795 " " " " 3.178

Mean of both determinations, 3.176.

Molecular volume, 175.4.

Anhydrous salt—

1.0725 grms., $t^\circ 13^\circ$

Sp. gr. 3.839.

Molecular volume, 121.7.

Crystalline form monosymmetric; beautiful crystals, protracted parallel to the orthodiagonal.

$a : b : c = 0.84906 : 1 : 1.12531$.

$\beta = 88^\circ 21'$.

Planes: $\infty P ; \infty P \infty ; -P \infty ; +\frac{1}{2}P \infty ; P \infty ; 2P \infty ; oP$. (C. Morton).

(To be continued).

Manufacture of Sulphuric Anhydride.—MM. Nebel and Fehrenbach heat together, in a retort, monohydrated sulphuric and phosphoric acids; or they pass sulphuric acid in vapour over an excess of monohydrated phosphoric acid.—*Journal f. Praktische Chemie*.

Researches on the Composition and Properties of Hydrogen Persulphide.—Paul Sabatier.—The author concludes that ordinary hydrogen persulphide is a mixture of hydrogen bisulphide with free sulphur and hydrogen monosulphide in solution. The general characters of stability of hydrogen persulphide follow from this complex character and its endothermic nature.—*Bulletin de la Soc. Chim. de Paris*.

PROCEEDINGS OF SOCIETIES.

THE INSTITUTE OF CHEMISTRY.

General Meeting, November 6, 1885.

Dr, ODLING, F.R.S., President, in the Chair.

THE PRESIDENT'S ADDRESS.

(Concluded from page 246.)

AND now comes the very practical question, what advantages are likely to result from our particular organisation; what gain to chemical science, what gain to the public, what gain to ourselves? Now these several matters are so bound up together, that we can scarcely isolate them from one another sufficiently even to allow of our taking them into separate and successive consideration. Any gain to ourselves as a body must depend on the higher esteem in which we are held by the public; and the higher esteem in which we are held by the public will depend in the main on the greater value of the services that we render; while the extent of service we may be able to render will be dependent again on the progress of chemical science generally, and on our own ever increasing proficiency as practical chemists. All three conditions act and are reacted on by one another; but despite their interdependence, we may yet be able to concentrate our chief attention on them one after the other. And first of all, as regards the gain that may be expected to accrue to chemical science, it is clear that the extension and improvement of chemical education is the one predominating means available to us for effecting the main purpose of the Institute, namely, the advancement of professional chemistry. The higher and more thorough the training of the professional chemist, the better will he be able to fulfil the demands made upon him, and the more will his services and the profession to which he belongs be held in respect. It will probably be taken for granted that, by reason of our organisation into a professional body, the inducements we shall be able to offer to those having it in contemplation to engage in the work of professional chemistry, will suffice to create in them a desire to affiliate themselves to our body, and cause them with that intent to educate themselves up to the standard of our requirements; and further than this, it will be conceded that the recognition of chemistry as an organised profession, standing on the same footing, say, as the professions of medicine and of engineering, and like these professions offering a definite career to its followers, and conferring on them the status that results from admission to the membership of a not undistinguished corporation, amenable to their influence, and with its high places open for their attainment, will be the means of attracting into the profession a class of students having the capability and determination to achieve for themselves the highest qualifications obtainable. And it may fairly be anticipated that in other ways, also, some of them to be presently referred to, the Institute of Chemistry will add alike to the social and substantial attractiveness of the chemical profession, whereby an increasing number of students, possessing a higher average of means and of literary cultivation, will desire to enter its ranks. Now, an increase of such-like students implies necessarily an increase and development of chemical education, with all its attendant influences on the progress of even pure science. It must not be forgotten, either, that it is to the present demands of applied chemistry in some form or another that the greater number of the schools and laboratories of chemistry throughout the country largely owe their origin and prosperity. That the cultivators of chemistry are numerous beyond the cultivators, say, of botany or of mathematics, is dependent not so much on the greater interest of the study, as on the greater demand made for what the cultivator of chemistry

is able to supply; while the very number of the cultivators affects the largeness of the field from which the distinguished cultivators successively emerge.

That the Institute of Chemistry, not only by what may be demanded as a necessary condition of admission to its membership, but far more by what may be required for the attainment of reward, distinction, and leadership within its ranks, will exert a potent influence on chemical education cannot surely be doubted. Our calling differs from most others in this, that the questions professionally submitted to us are essentially scientific questions, ever calling on us to deal with them in a scientific spirit. Forming as they do, for the most part, the subjects of a veritable scientific investigation, it is to a training in investigation, more than to any other form of chemical education, that fitness for the determination of these questions, and the professional success attendant on their determination, must depend. At the present time, the chemical education of the country, much as it has advanced within the last thirty years, cannot but be felt as deficient, and deficient mainly by reason of its brevity. To become acquainted in some measure with the great body of facts and their relationships to one another, to acquire a familiarity with the more important literature, doctrine, and philosophy of the subject, and to obtain some degree of practical skill and insight into its experimental methods, is as much as can be expected of the ordinary student, within the present brief period of his educational career in science. Anyhow, he can rarely get beyond the stage of finding out for himself, in a few select cases by way of practice, what has long before been found out and established by the investigations of others. These are matters that can be more or less satisfactorily tested by examination; and with all the drawbacks incident to the examinational system, it has yet its unquestionable merits, and is so far a necessity that it is difficult to see how its use can be wholly dispensed with. On the path of original inquiry, the time at the disposal of the ordinary student but rarely permits him to enter; and with the demands of forthcoming examinations pressing upon him, it is scarcely desirable that he should enter. But the education in science which can be satisfactorily tested and scored up by examiners is but the beginning of a really scientific education. With a professional career before him, the student of science can afford to prolong the period of his education, and devote himself to work which looks for its reward in other than a mere examinational success. A training in the pursuit of original inquiry is not only the particular training which, more than any other, fits him for the work of his future profession, but the achievement of success in such inquiry constitutes his surest means of making himself known, and of becoming entrusted with the professional work for which his training has especially qualified him. An increasing demand set up in this way, for instruction and guidance in the work of research, cannot but react beneficially on the methods of the scientific teacher; while the early formation of a taste for research will not be without a far-reaching influence on the after life of the student. But more than this, among the number of young men taking up the study of chemistry by reason of its opening out to them a professional career, and cultivating original work as the recognised means of qualifying themselves for that career, some proportion at any rate will find in the pursuit of research the vocation for which they are especially qualified, and for which they will, in the seed-sowing time of their life, be willing to make, as others have made before them, even considerable professional sacrifices. And the advancement of professional chemistry may be expected to affect the progress of pure science in yet another way. To how many of us has not a study of the subjects of our professional work, and the exceptional opportunities so freely afforded us for their professional study, created a wide extension of our knowledge, even if it has not opened out what have been to us altogether new fields of inquiry. To how many of us, further, has not a study

under the advantageous opportunities afforded us, of the subjects of our professional work, suggested fruitful topics of purely scientific interest, which but for their having been first brought under our notice professionally, would never have occurred to us as matters for investigation at all. With the ever-extending need for the services of the professional chemist, and with the holders of chemical appointments spread, as they are becoming spread, all over the country, and with a supply of young chemists, well educated generally, specially trained for their work, imbued with a spirit of inquiry, interested in the solution of scientific problems, and practised in the methods of their solution, what progress, alike in pure science and in the higher applications of science, may not be hoped for, as a result of that advancement of the professional education and professional status of practising chemists, which our organisation may be expected so largely to influence and bring about.

As regards the gain that will be likely to accrue to the community, from the influence which the Institute of Chemistry cannot but exert in maintaining and raising the standard of capability and professional character among practising chemists, it may be useful to quote a few paragraphs from the preamble of the Charter under which the Institute has now been incorporated. It is therein represented:—

"That the profession of analytical and consulting chemistry is one of great importance to the public, and having regard to the rapidly increasing application of chemistry to legal investigations, to public health, to the adulteration of food, to agriculture, and to the arts and manufactures, it is desirable that persons practising the profession of analytical and consulting chemistry should have both a practical and scientific knowledge thereof.

"That it is a matter of increasing importance to government departments, to corporate bodies, and others requiring the assistance of persons competent to practice in analytical chemistry and to advise in technological chemistry, that such persons should be properly trained, and that their qualifications should be attested by certificates of competency granted by a scientific body possessing sufficient status; and that at present there is no institution or corporate body which has power to issue such certificates.

"That the said Institute was not established for the purposes of gain, nor do the members thereof derive or seek any pecuniary profits from their membership, but the society aims at the elevation of the profession of consulting and analytical chemistry, and the promotion of the efficiency and usefulness of persons practising the same, by compelling the observance of strict rules of membership, and by setting up a high standard of scientific and practical proficiency.

"That it would greatly promote the objects for which the said Institute has been instituted, and would also be for the public benefit, if the members thereof were incorporated by Royal Charter, with power to afford facilities for the better education and examination of persons desirous of qualifying themselves to be public and technical analysts and chemical advisers on scientific subjects of public importance, and with power to grant such certificates of competency as aforesaid; as, besides other advantages, such incorporation by Charter would be a public recognition of the importance of the profession of analytical and consulting chemistry, and would tend gradually to raise its character, and thus to secure for the community the existence of a class of persons well qualified to be employed in the responsible and difficult duties often devolving upon them."

In relation to the topic of public utility dwelt upon in these paragraphs, it would, under any circumstances, be superfluous to enlarge on the general proposition as to the dependency of national progress on the extension and application of scientific knowledge; and it is especially unnecessary at the present time, in view of Sir Lyon

Playfair's recent disquisition on the matter in his presidential address to the British Association. But it may be safely urged, that with scarcely any other department of practical science is national progress so intimately connected as it is with the department of chemistry. The special applications of chemistry, in relation to agriculture, to metallurgy, to technology generally, and to matters and questions of war material, of gas supply, water supply, food supply, and of hygiene, medicine, and jurisprudence, are ever being resorted to for the advancement and elucidation of these important arts and matters, affecting so largely the individual and national life; whence it should follow that to increase the number, and insure the greater competency of the professional men entrusted by the community to deal with these affairs may constitute a matter of even national concern. And as regards departments, corporations, boards, and persons in general, needing the services of the professional chemist, the gain to them in having an increased supply of more cultivated and better trained men from whom to make their selection, and from having it in their power to satisfy themselves of the capability and training of those offered for their selection, by the assurance of a responsible body specially qualified and authorised to give that assurance, would seem to be beyond question. As an incident of the past it may fairly be noted, without any disparagement to the meritorious body of men now holding the positions of public analysts throughout the country, that at the time, not so long ago, of the Act of Parliament coming into force under which these appointments were first made, the choice of really competent candidates was very small, that the several boards having the responsibility of making the appointments had no means of assuring themselves of the competency of the different candidates, and that, as a result, not a few unfortunate appointments were made, which had somehow or other to be in effect revoked; while even among those public analysts who have since amply justified their appointment, some at least feel themselves considerably impeded in their proper chemical work, and unable to take up, as they would desire, other branches of chemical work, by the circumstance of that work being one for which they have not had the advantage of an adequate early training. Of such a state of things, the existence of the Institute of Chemistry should prevent any possible recurrence; while it has the further merit of affording to the public yet other advantages of a wholly different kind. For by its agency there will be offered to all persons and boards requiring the services of the professional chemist, not only an increased supply of better trained men, and an assurance of the sufficiency of their training, but there will also be offered to these persons and boards, the advantage of having to deal with men of education and standing, having a professional character to maintain, amenable to the influence of association with the leaders of their profession, under obligation to observe a high tone of professional conduct, and liable to have any departure from such conduct made the subject of inquiry and possibly of reprimand by their fellows; or, it may be, even a cause of their suspension or exclusion from the ranks of the professional organisation, their continued membership of which could only bring into discredit.

And now as regards the advantage which the existence of the Institute of Chemistry is likely to afford to ourselves. To those of us who have already attained the higher steps on the ladder of success it can scarcely afford any personal advantage whatever, save that which may result from a gradual increase in reputation of the profession to which we belong. But to all alike, as members of the general body, regardless of our past and present obligations to the profession, and taking a lively interest in its future well-doing, the incorporation of the Institute of Chemistry by Royal Charter cannot but be looked upon as a matter of personal congratulation. It will be our own fault if the so incorporated Institute does not prove a

means of raising the character and increasing the usefulness of the chemical profession, of promoting the influence it should be able to exert, and of contributing to the public estimation in which its individual members will be held. The general recognition of practising chemists as members of a distinct profession, constituted only of specially trained men, can scarcely fail to secure for the entire body a degree of consideration and respect very desirable in itself, and not without a substantial value when accorded alike by state departments, and by municipal and other local authorities, and by members of those particular learned professions with which the work of the chemist brings him more especially into association. And with the growing respect entertained for the profession at large, there cannot but spring up an increasingly favourable, and not unserviceable, feeling towards the individual, by reason of the profession to which he belongs. In all cases, indeed, formal inclusion within the ranks of a learned profession, necessarily limited in its numbers, demanding from its members the possession of special qualifications, and exacting from them the obligation to observe a high standard of conduct, is found to afford noteworthy advantages, social and material, to the persons so included.

The degree of advantage attaching to membership of an organised corporation will depend, of course, on the character, reputation, and traditions of the particular corporation. A new corporation like our own, having no traditions to fall back upon, has to create its reputation, acquire its influence, and make its own history. There is much that the Institute may do for its members in the way of good; while by the exercise of an influence for good, it will acquire for itself a degree of respect enabling it to effect yet greater good. There are indeed many matters affecting the relationship of practising chemists, both to one another and to the parties for whom they are acting, in which it may exert its influence in favour of what is creditable and high-minded; and so of what is, in the long run, most advantageous. But it is not only in respect to our personal relationships, but as concerns also the wider relationship of the profession to the public at large, that the ability to exert a corporate, instead of a merely individual action in reference to matters affecting our status and interests, may be expected to prove beneficial. Our representation, in any matter with which we are specially concerned, may indeed not be attended to; but it can scarcely now be denied a hearing, or be treated as though of no account. Among its other objects, the Institute of Chemistry exists undoubtedly for the purpose of improving the position and prospects of professional chemists. It does not, however, lay itself out, nor is it fitted, for the exercise of what may be called a trades-union method of proceeding. Competition of the unqualified, and meretricious, and professionally irresponsible man, with the capable and carefully trained member of an exacting profession, will still be possible; but the trained and capable man will now have the advantage of having his competency and training attested by the guarantee of a public body, qualified, and officially authorised, to afford him such guarantee; while the community at large, called on to discriminate between the competitors, will be afforded adequate means of discrimination; and will have at their command the assurance, both of capability and of professional character, which membership of a more or less highly reputed corporation implies. As affecting in this way our own interests, the more or less reputation of the Institute becomes to us a matter of personal concern. Necessarily, however, its reputation can be but of slow growth; and the younger of our members can, with the larger measure of confidence, look forward to experience the benefits derivable from its increase of reputation. In particular, the influence which the Institute of Chemistry may exercise on the estimation accorded to professional chemists through the stimulus which it will afford to the higher scientific education of those entering the profession, cannot obviously make itself felt for many years. But we

may all of us, from the present outset, promote the reputation of the Institute, in which we have so manifest an interest, by our own individual conduct. Rules of professional conduct, opposed to prevalent habits, are for the most part incapable of enforcement; but good example will tell in the long run, and the knowledge that certain courses of action are approved, while other courses of action are disapproved, by the general body cannot fail to bring about a survival of the fittest. The advancement of the Institute of Chemistry is our personal interest, and the estimation which may be gained for it is our personal gain. Each one of us may, and should, promote the reputation of the Institute by his own individual character and conduct, by the soundness of his professional work, and by his scrupulous avoidance of everything which in other professions is held to be derogatory.

PHYSICAL SOCIETY.

November 14th, 1885.

Prof. GUTHRIE, President, in the Chair.

MR. G. M. WHIPPLE described and demonstrated experimentally the process of testing thermometers at and near the melting-point of mercury as carried on at Kew. About 20 pounds of mercury are poured into a wooden bowl and frozen by carbonic acid, snow, and ether. The mercury is stirred with a wooden stirrer, and the snow is added till the experimenter feels by the resistance to stirring that the mercury is freezing. The stirring is continued for some time, which causes the mercury to become granular instead of a solid mass. The thermometers are then inserted together with a standard and compared. About 100 mercury or 40 spirit thermometers can be thus examined in half an hour, using about 200 gallons of carbonic acid gas, compressed sufficiently to form the snow. The bowl, ether, and mercury are cooled first to -10°C . by an ordinary freezing mixture. The average correction at the melting-point of mercury is now less than 1°F .: when the process was introduced in 1872 it amounted to 5° , but has steadily decreased.

"On the Electromotive Force of certain Tin Cells." By Mr. E. T. HERROUN.

Mr. Herroun has examined the electromotive forces of cells, in which tin in a solution of its salts was opposed to copper, cadmium, and zinc in solutions of their corresponding salts, the solutions being of equal molecular strengths. The salts used were sulphates, chlorides, and iodides, and the cells were of the ordinary "Daniel" form with a porous vessel. To prevent the formation of basic salts it was necessary to add a little free acid to the solution of the tin salt, and to counterbalance the influence of this acid upon the E.M.F. as far as possible, an equal proportion of free acid was added to the other solution.

Prof. G. MINCHIN pointed out the importance of performing these and similar experiments upon tin in the dark, as by allowing light to fall upon the tin plate a considerable photo-electric effect would be obtained.

Prof. FLEMING insisted upon the great importance of temperature corrections in all experiments upon two fluid cells.

"On the Law of the Electro-magnet and the Law of the Dynamo." By Prof. S. P. THOMPSON.

It cannot be said up to now that any particular law has been generally accepted giving the relation between the current in the coils of an electro-magnet and the magnetism induced by it in the core. Many empirical formulæ have been given, most of which are entirely wrong. One, however, recently enunciated by Fröhlich gives a relation which agrees very closely with observed values. This formula is $m = \frac{i}{a + bi}$, where m is the magnetic moment of the core, i the current, and a and b constants depending

upon the geometrical form of the magnet and the nature and previous history of the iron core. Fröhlich obtained this relation by experimenting with a series dynamo. It is purely empirical, but since it agrees so well with the facts as to give values for the magnetism of the core agreeing almost within experimental error with those observed, there is great probability of some law being at its base. And this law Prof. Thompson believes to be one that was stated years ago by Lamont:—"The magnetic permeability varies with the quantity of magnetism the iron is capable of taking up." This may be expressed by the formula—

$$\frac{d m}{d i} = k(M - m).$$

Integrating which, and expanding e^{-ki} in powers of i ,—

$$m = Mki \left\{ 1 - \frac{ki}{2} + \frac{k^2 i^2}{6} - \dots \right\}$$

Expanding Fröhlich's equation in powers of i we get—

$$m = \frac{i}{a} \left\{ 1 - \frac{bi}{a} + \frac{b^2 i^2}{a^2} - \dots \right\}$$

If ki is not great these expressions will coincide in form very closely, and the results lead Prof. Thompson to accept Lamont's expression as being that of a real physical law.

Prof. PERRY suggested that Lamont's law gave good results from its being an approximation to Weber's theory of induced magnetism; but Prof. THOMPSON maintained that it represented observed facts better than that theory, which, as developed by Maxwell, shows a decided discontinuity in the process of magnetisation not actually observed.

Prof. FLEMING remarked upon the similarity of Fröhlich's expression to that for the current through a voltmeter, the part $a + bi$ corresponding to the apparent resistance, which may be considered in this case as the resistance to magnetisation of the core-air circuit, and which, like that of the voltmeter, varies with the current.

ROYAL INSTITUTION OF GREAT BRITAIN.
General Monthly Meeting, Monday, November 2, 1885.

WARREN DE LA RUE, M.A., D.C.L., F.R.S.,
Manager and Vice-President, in the Chair.

THE following were elected Members:—Joseph Wilson Swan, Mrs. J. W. Swan, General J. F. Tennant, R.E., F.R.S.

The Presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

CORRESPONDENCE.

α -NAPHTHYLAMINE SULPHONIC ACID.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. lii., p. 249, Dr. Alfred Wolf quotes a passage from the *Dyer and Calico Printer* and draws from it certain inferences. In referring to this paper (Oct. 15, 1885, p. 158), it will be seen that he does not correctly quote the passage in question, which reads as follows:—"We (I. L. and Co.) were the first to replace this very expensive agent by common vitriol, and as far back as 1881 we began to manufacture colours from α -naphthylamine sulpho-acid, and β -naphthylamine sulpho-acid, produced in this way." Now it does not require much knowledge to distinguish between manufacturing

raw materials used in the production of colouring-matters and manufacturing colouring-matters.

As a matter of fact Messrs. I. L. and Co. have already prepared α -naphthylamine sulphonic acids by means of ordinary sulphuric acid in 1879, and on referring to the books of my firm I find that the manufacture of rocelline was started in 1880, while in 1881 the manufacture of colouring-matters from β -naphthylamine sulphonic acid was commenced.

In justice to Messrs. Winther and Neville I may, however, add that, although they cannot claim priority to the use of ordinary sulphuric acid, their process of obtaining sulpho-acids of certain amines by treating them with molecular weights of sulphuric acid was an improvement in the production of these compounds.

IVAN LEVINSTEIN.

Manchester, Nov. 16, 1885.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 18. November 2, 1885.

Compounds of Silver Nitrate with the Alkaline Nitrates.—A. Ditte.—When a mixed solution of silver and potassium nitrates is evaporated a compound is obtained composed of equal mols. of the two nitrates. With rubidium and probably with caesium nitrates analogous compounds are obtained. The same is the case with ammonium nitrate. With sodium and lithium nitrates double salts of a definite composition are not obtained.

On the Anhydrous Cerium Chloride and Silicate.—M. Didier.—This paper will be inserted in full.

Biedermann's Central Blatt für Agrikultur Chemie, Vol. xiv., Part 5.

Temperature of the Soil and Rainfall.—J. Breitenlohner.—The rise of temperature observed after thunder-rain is proved to be simply a consequence of absorption. As this liberation of heat ensues among the room occupied by the roots of most cultivated plants, this phenomenon possesses doubtless a certain value. The well-known fertilising action of thunder-rain and of so-called warm rain will be thus in part explained.

Self-purification of Natural Waters.—F. Emich.—The author has made experiments on the behaviour of water on exposure to the air, and on agitation with air. He has experimented also with sterilised water, and on the behaviour of waters under the action of ozone and hydrogen peroxide. The self-purification of waters, *i. e.*, the decomposition of their organic and inorganic impurities, may result either from a purely chemical process (oxidation) or from a biological process. It appears that on exposing water to the air, or agitating it together, self-purification ensued only when the water had not been sterilised by boiling, nor had been protected against the entrance of germs. If, on the other hand, a sterilised water had been subsequently exposed to the air, or had been infected by the mixture of ordinary water, it underwent the same changes as water freely exposed to the air. The oxidisability and the proportion of ammonia decreased, whilst nitrous or nitric acid was formed. When, therefore, the development of organisms in the water was made impossible, self-purification was excluded. Hence the inference is justifiable that the two phenomena are causally connected. Direct oxidation by atmospheric oxygen does not occur. Ozone and hydrogen peroxide

may possibly co-operate in the natural purifying process, but they certainly play a very subordinate part. The kinds of organisms which effect the purification of waters, converting highly complex compounds into simpler ones, or in short mineralising them, is very different according to circumstances. A change of species has been observed in one and the same water-course, in the successive stages of its pollution. The self-purification of water in the open channels of rivers is thus brought into connection with the self-purification of soils in which, according to Schlösing and Müntz, nitric acid is formed only by the intervention of organisms. The entire question of self-purification is thus withdrawn from the sphere of pure chemical research.

Self-purification of the Soil.—J. Soyka.—The author, in a series of experiments, has examined the power of the soil to withdraw poisons from solution, and to decompose them. Solutions of various strength, of strychnine, sulphate, hydrochlorate, and acetate, were filtered through a cylindrical stratum of gravelly soil, 0.8 metre in depth, 10 c.c. of the solution being poured on daily. After the soil had taken up a quantity of the solution equal to its capacity for water, the excess filtered through perfectly free from strychnine. The size of the granules of the soil (0.3 to 4 m.m.) had no influence. The addition of the strychnine solutions was then continued until the soil could no longer retain any strychnine. Analysis showed that a gravel-soil can withdraw from solution 0.5 to 0.6 per cent of its own weight of strychnine salt, and 0.4 per cent of its weight of pure strychnine. Similar results were obtained with other alkaloids. The soil decomposes the salts which it thus withdraws from solution quantitatively, the acid reappearing in the filtrate, whilst the alkaloid remains in the soil, and at first unchanged, as was proved both chemically and physiologically. The subsequent destiny of the absorbed alkaloids was determined by prolonged experiments. In 167 days strychnine lost 60 per cent of its nitrogen, which appeared as a nitrate in the filtrate, so that in time a perfect purification of the soil from the poison might be expected. If a soil has absorbed quinine a different final product appears in the filtrate,—ammonia. This difference is probably determined by the different action of the alkaloids upon the nitrifying alkaloids in the soil. Peat absorbs the alkaloids more readily than gravel, but decomposes them more slowly.

Influence of the Addition of Sand to Peaty Soils.—Dr. M. Fleischer.—Not suitable for abstraction.

Movement of Water in Moss-Plants, and their Influence upon the Distribution of Water in the Soil.—F. Oltmanns.—The mosses in question are species of *Hylocomium*, *Dicranum undulatum*, *Sphagnum palustre*, *Mnium undulatum*, and *Polytrichum gracile*. The author's conclusions are that a living and a dead moss-turf are quite alike in their action upon the subjacent soil. Moss hinders the evaporation of considerable quantities of water from the soil as long as it retains a certain quantity of water, whilst a bare soil quickly dries up. Moss withdraws no water from the subjacent soil.

Researches on the Capacity for Water, and the Evaporating Power of various Materials covering the Soil.—E. Wollny.—Not suitable for abstraction.

The Economical Utilisation of Sewage.—M. Kiepert.—Irrigation grasses (Italian rye-grass and Timothy) have to be removed to a fallow- or stubble-field to dry. Of another kind of grass, not named, it is said to be unwillingly eaten by cows in its fresh state.

Iron Sulphate as a Plant-Food.—Dr. Griffiths.—From the CHEMICAL NEWS.

The Action of Phosphoric Acid in Different Forms of Combination.—Prof. Pittbogen.—The phosphates which act most rapidly are mono and di-calcium phosphates, precipitated phosphates, and good superphosphates made from guanos, animal charcoal, bone-ash, and pure

apatites. Next follow tricalcium phosphate (*e. g.*, steamed bone-dust) and superphosphates from inferior phosphorites. Lastly come iron and aluminium phosphates, and Kladno phosphate.

Manurial Experiments.—Prof. König.—Experiments on the action of green crops ploughed into the ground, of precipitated phosphates, horn-dust, and kainite upon a variety of crops.

Journal de Pharmacie et de Chemie.

Series 5, Vol. xii., No. 7, October 1, 1885.

On a Poisonous Product extracted from Pure Cultures of the "Comma Bacillus."—MM. Nicati and Rietsch.—The experiments of the authors go to prove that in pure cultures there is formed a poisonous substance which may be extracted by the procedures commonly employed for the separation of the alkaloids. As contradictory and negative results have been previously obtained, the authors are now examining if the formation of the poison is constant in these cultures, or if certain especial conditions are required.

Incandescence of Copper and Iron in a Mixture of Acetylen and Air.—Felix Bellamy.—Copper and iron remain inactive in the vapours in which platinum takes a red heat, such as hydrogen and ether, but become incandescent in a mixture of acetylen and air.

On Panification.—M. Balland.—The conclusion of a lengthy memoir.

A Desiccator.—M. Yvon.—This apparatus is composed of a rectangular plate of copper, coated with platinum or nickel, 4 or 5 m.m. in thickness. On one of the sides of this plate is a small trough, which receives the reservoir of an attenuated thermometer graduated from 60° to 100°. The trough is filled with copper filings to ensure contact. The arrangement of the apparatus is the same as that of Schlösing's sand-bath. In a few minutes the plate may be raised to 100°, and kept at that temperature by means of the tap, or by a regulator. The filter is spread upon the plate, and weighed when dry. The precipitate is then collected and well washed. The filter, after the removal of the precipitate, is again dried and washed.

Detection of Colouring-matters derived from Coal added fraudulently to Wine.—M. Jay.—The author places 20 c.c. of the sample in a test-tube, adding 5 drops of ammonia, and, after agitation, 3 to 4 c.c. of pure amyl alcohol. If the latter takes a rose, a golden yellow, or a violet colour, the wine is certainly artificially coloured.

The Absorption-Spectra of some Colouring-matters.—MM. Girard and Pabst.—Already noticed.

MISCELLANEOUS.

Society of Arts.—The Hundred and Thirty-second Session of the Society of Arts commenced on Wednesday, the 18th inst., when the Opening Address was delivered by Sir Frederick Abel, C.B., D.C.L., L.L.D., F.R.S., Chairman of the Council. The following are amongst the papers announced:—Prof. Silvanus P. Thompson, "Apparatus for the Automatic Extinction of Fires." Prof. Francis Elgar, L.L.D., F.R.S.E., M.Inst.C.E., "The Load Line of Ships." F. Edward Hulme, F.L.S., F.S.A., "Technical Art Teaching." Dr. C. Meymott Tidy, "The Treatment of Sewage." C. V. Boys, "Calculating Machines." George Clulow, "The History and Manufacture of Playing Cards." W. H. Preece, F.R.S., "Domestic Electric Lighting." Prof. R. Meldola, F.C.S., "The Scientific Development of the Coal Tar Industry." Six courses of Cantor Lectures have been arranged:—"The Microscope," by John Mayall, jun.; "Friction" by Prof.

H. S. Hele Shaw; "Science Teaching" by Prof. F. Guthrie, F.R.S.; "Petroleum and its Products," by Boverton Redwood, F.C.S.; "The Arts of Tapestry Making and Embroidery," by Alan S. Cole; "Animal Mechanics," by B. W. Richardson, M.A., M.D., F.R.S. The subject of the Juvenile Lectures this year will be on "Waves," and the lecturer, Prof. Silvanus P. Thorapson, D.Sc. Dates and further particulars will be announced in the Society of Arts Journal.

NOTES AND QUERIES.

* * Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Butyric Acid.—Will any correspondent tell me how to detect butyric acid in glycerin.—A.

Waste Products.—(Reply to "Stagnation").—I have a by-product containing 65 to 75 per cent iron, 8 to 10 per cent silica, and 2 to 4 per cent alumina. I shall be glad to give further particulars if desired.—WM. VEITCH, Crieff, N.B.

MEETINGS FOR THE WEEK.

MONDAY, 23rd.—Medical, 8.30.

TUESDAY, 24th.—Royal Medical and Chirurgical, 8.30.
Institution of Civil Engineers, 8.

WEDNESDAY, 25th.—Society of Arts, 8.

THURSDAY, 26th.—Royal, 4.30.

Philosophical Club, 6.30.

FRIDAY, 27th.—Quekett Club, 8.

Clinical, 8.30.

SATURDAY, 28th.—Physical, 3. "On the Calibration of Galvanometers by a Constant Current," by T. Mather. "On a New Driving Clockwork of Isochronous Motion," and "On a New Direct-Vision Spectroscope," by A. Hilger. "On a Machine for the Solution of Equations," by C. V. Boys. "On a Machine for the Solution of Cubic Equations," by H. H. Cunyngnam.

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THE CHEMICAL NEWS.

VOL. LII. No. 1357.

NOTE OF SOME CONDITIONS OF THE DEVELOPMENT AND OF THE ACTIVITY OF CHLOROPHYLL.*

By Professor J. H. GILBERT, LL.D., F.R.S.

ALL who are accustomed to observe vegetation must have been struck with the great variety of shades of green which the foliage of different plants presents. Without pretending to generalise further, it may be stated that, at any rate so far as our common agricultural plants are concerned, they show somewhat characteristic shades of colour, according to the *Natural Order* to which they belong,—the Leguminosæ differing from the Gramineæ, the Cruciferæ, the Chenopodiaceæ, and so on. But the same description of plant will exhibit very characteristic differences, not only at different stages of growth, but at the same stage in different conditions of luxuriance, as affected by the external conditions of soil, season, manuring, &c., but especially under the influence of different conditions as to manuring.

The Rothamsted field experiments have afforded ample opportunity for observations of this kind, and it has been quite evident that, in a series of comparable experiments with the same crop, depth of green colour by no means necessarily implied a finally greater amount of carbon assimilation; whilst we have long ago experimentally proved that the deeper colour was associated with relatively high percentage of nitrogen in the dry or solid substance of the herbage; and this obviously means a lower relation of carbon to nitrogen.

Mentioning these facts to Dr. W. J. Russell, who has devoted so much attention to the subject of chlorophyll, he kindly undertook to make comparative determinations of the amounts of chlorophyll in parallel specimens, in which we were to determine the percentages of dry matter and of nitrogen. Accordingly, in June, 1882, during the period of active vegetation, Dr. Russell spent a day at Rothamsted for the purpose of collecting appropriate samples, which were taken from several differently manured plots of meadow-grass, wheat, barley, and potatoes, respectively.

The following table gives the results of some of these experiments,—namely, the percentages of nitrogen,

Relation between Nitrogen Accumulation, Chlorophyll Formation, and Carbon Assimilation.

(The figures in parentheses represent determinations in the not fully dried substances.)

	Nitrogen per cent in Dry Substance.	Relative Amounts of Chloro- phyll.	Carbon assimilated per acre per annum.	
			Actual.	Difference.
			lbs.	lbs.
<i>Hay—</i>				
Gramineæ	1.190	0.77	—	—
Leguminosæ	2.478	2.40	—	—
<i>Wheat—</i>				
Ammonium salts only (1.227)	2.00	1398	—824	
Ammonium salts and mineral manure ..	(0.566)	1.00	2222	—
<i>Barley—</i>				
Ammonium salts only (1.474)	3.20	1403	—685	
Ammonium salts and mineral manure ..	(0.792)	1.46	2088	—

* Abstract of a Paper read before Section B, British Association, Aberdeen Meeting.

and the relative amounts of chlorophyll, in the separated gramineous and the separated leguminous plants in the mixed herbage of grass-land; in specimens of wheat grown by a purely nitrogenous manure, and by the same nitrogenous manure with a full mineral manure in addition; and in specimens of barley grown by a purely nitrogenous manure, and by a mixture of the same nitrogenous manure and mineral manure in addition. It is to be borne in mind that the specimens were collected while the plants were still quite green and actively growing. It should be further explained that the amounts of chlorophyll recorded are, as stated in the table, relative and not actual; that is to say, the figures show the relative amounts for the individual members of each pair of experiments, and not the comparative amounts as between one set of experiments and another.

It will be seen in the first place that the separated leguminous herbage of hay contained a much higher percentage of nitrogen in its dry substance than the separated gramineous herbage; and that, with the much higher percentage of nitrogen in the leguminous herbage, there was also a much higher proportion of chlorophyll. Indeed, under comparable conditions the Leguminosæ eventually maintain a much higher relation of nitrogen to carbon than the Gramineæ; in other words, in their case carbon is not assimilated in so large a proportion to the nitrogen taken up.

Next, it is to be observed that the wheat-plants manured with ammonium salts alone show a much higher percentage of nitrogen than those manured with the same amount of ammonium salts, but with mineral manure in addition. The high proportion of chlorophyll again goes with the high nitrogen percentage; but the last column of the Table shows that, with the ammonium salts without mineral manure, with the high percentage of nitrogen, and the high proportion of chlorophyll, in the dry substance of the green produce, there is eventually a very much less assimilation of carbon. The result is exactly similar in the case of barley. The plants manured with ammonium salts alone showing the higher percentage of nitrogen and the higher proportion of chlorophyll, but eventually a much lower assimilation of carbon.

It is evident that the chlorophyll formation has a close connection with the amount of nitrogen assimilated, but that the carbon assimilation is not in proportion to the chlorophyll formed, if there be a relative deficiency of the necessary mineral constituents available. No doubt there had been as much, or more, of both nitrogen assimilated and chlorophyll formed over a given area, where the mineral as well as the nitrogenous manure had been applied, the lower proportion of both in the dry matter being due to the greater assimilation of carbon, and consequent greater formation of non-nitrogenous substances.

It is of interest to observe that these results of experiments in the field are perfectly consistent with those obtained by vegetable physiologists in the laboratory, they having found that the presence of certain mineral or ash constituents, and especially that of potassium, is essential for the assimilation of carbon, no starch being formed in the grains of chlorophyll without the aid of that substance. Sachs says—"Potassium is as essential for the assimilating activity of chlorophyll as iron for its production."

A Coloured Reaction of Rhodium.—E. Demarçay. —A neutral or faintly acid solution of ammonium chlororhodate being with a slight excess of sodium hypochlorite gives a yellowish precipitate if sufficiently concentrated. On adding then drop by drop a 20 per cent solution of acetic acid and taking care to agitate after each drop, the precipitate takes a very intense orange colour, which quickly fades, giving a greyish precipitate, and finally a very intense sky-blue, which persists for some hours. The solutions of chlorides of the other metals of the platinum group under the same conditions give no action with sodium hypochlorite.—*Comptes Rendus*, Vol. ci., No. 19.

NEW RESEARCHES ON THE COMPOUNDS
OF DIDYMIUM.*

By P. T. CLEVE.

(Continued from p. 256)

Selenate of Didymium and Ammonium,
 $\text{DiNH}_4\text{SeO}_4 + 5\text{H}_2\text{O}$.

It crystallises, as does the analogous potassium salt, in large and well formed red prisms which are easily soluble in water.

0.8745 grm. was treated as the potassium salt, and gave 0.2572 grm. Se and 0.2729 grm. Di_2O_3 .0.9106 grm. gave 0.2678 grm. Se and 0.2843 grm. Di_2O_3 .

In per cent—

			Calculated.	
Di_2O_3 ..	31.21	31.22	166	30.97
$(\text{NH}_4)_2\text{O}$..	—	—	26	—
SeO_3 ..	47.28	47.28	254	47.39
H_2O ..	—	—	90	—
			536	

Specific gravity—

2.0102 grm., crystals, $t^\circ 15^\circ$ sp. gr. 2.957

1.4062 " " " " 2.961

Mean of both determinations, 2.959.

Molecular volume, 181.1.

Crystalline form rhombic; well formed crystals, protracted parallel to the vertical axis.

 $a : b : c = 0.88784 : 1 : 0.7111$.Planes: ∞P ; $\infty \bar{P}$; $\infty \bar{P}$; \bar{P} .Optical positive. The plane of the optic axes parallel to $\infty \bar{P}$. (C. Morton).*Sulphite of Didymium,*
 $\text{Di}_2\text{SO}_3 + 6\text{H}_2\text{O}$ (or $2\text{H}_2\text{O}$ dried at 100°).

Oxide of didymium is easily soluble in a solution of sulphurous acid in water. If the solution be heated on the water-bath, a voluminous precipitate of the sulphite is thrown down. Prior to analysis the salt was pressed between filter-paper.

0.3228 grm. lost by heating to 100° 0.0384 grm. and gave 0.2931 grm. Di_2SO_4 .0.3579 grm. lost by 100° 0.0433 grm. H_2O and gave 0.3232 grm. Di_2SO_4 .

In per cent—

			Calculated.	
Di_2O_3 ..	52.70	52.41	332	52.53
SO_2 ..	—	—	192	—
H_2O at 100° ..	11.90	12.10	72	11.39
$2\text{H}_2\text{O}$..	—	—	36	—
			632	

*Selenites of Didymium.*1. *Basic salt.* $3\text{Di}_2\text{O}_3, 8\text{SeO}_2 + 21\text{H}_2\text{O}$ (or $7\text{H}_2\text{O}$ dried at 100°).By mixing the solutions of neutral selenite of sodium and sulphate of didymium a very voluminous and gelatinous precipitate is thrown down, resembling the hydroxide of didymium. It was dried at 100° .0.9488 grm. dissolved in HCl and precipitated with SO_2 , gave 0.2940 grm. Se, and from the filtrate 0.4782 grm. Di_2O_3 was precipitated as oxalate.

In per cent—

			Calculated.	
$3\text{Di}_2\text{O}_3$..	50.40	996	49.55	
8SeO_2 ..	43.54	888	44.18	
$7\text{H}_2\text{O}$..	(6.06)	126	6.27	
	100.00	2010	100.00	

A precipitate, obtained from acetate of didymium and the selenate of ammonium, gave by analysis:

0.3759 grm., pressed between filter-paper, gave on ignition 0.1660 grm. Di_2O_3 .

0.4068 grm. gave 0.1115 grm. Se.

			Calculated.	
$3\text{Di}_2\text{O}_3$..	44.16	996	44.03	
8SeO_2 ..	39.72	888	39.26	
$21\text{H}_2\text{O}$..	(16.12)	378	16.71	
	100.00	2262	100.00	

It is really remarkable that the ratio between Di_2O_3 and SeO_2 is so constant in both these preparations. M. Nilsson observed the same ratio and assigned the formula $3\text{Di}_2\text{O}_3, 8\text{SeO}_2, 28\text{H}_2\text{O}$ to the precipitate obtained by the first of the above methods. The basic selenite of samarium, prepared in precisely the same manner, gave a perfectly analogous formula, viz., $3\text{Sm}_2\text{O}_3, 8\text{SeO}_2, 7\text{H}_2\text{O}$ (dried at 100°).2. *Acid salt.* $\text{Di}_2\text{O}_3, 4\text{SeO}_2 + 5\text{H}_2\text{O}$. By adding an excess of selenious acid to the solution of the acetate of didymium a lilac-coloured crystalline precipitate is thrown down. The salt loses at 105° 4.68 per cent H_2O or 2 mol. (calc. 4.14).0.5945 grm. gave by ignition 0.2296 grm. Di_2O_3 .0.8247 grm. gave 0.2970 grm. Se and 0.3165 grm. Di_2O_3 .

0.7205 " 0.2587 " 0.2758 "

In per cent—

				Calculated.	
Di_2O_3 ..	38.62	38.38	38.28	332	38.34
SeO_2 ..	—	50.60	50.45	444	51.27
H_2O ..	—	(11.02)	(11.27)	90	10.39
				866	100.00

Borate of Didymium, DiBO_3 .

On adding oxide of didymium to fused borax an amethyst-coloured glass is obtained, which heated for some time over a Bunsen burner becomes an enamel. Under the microscope it appeared as a transparent glass full of minute prisms. The mass was powdered and carefully treated with cold water containing hydrochloric acid. The borax was thus dissolved and a mixture of boracic acid and borate of didymium was left. The boracic acid was dissolved out with boiling water, after which the borate was washed with alcohol and dried. The salt was tested for sodium, but was free from it. It is easily soluble in hydrochloric acid.

0.6648 grm. was dissolved in HCl and gave with oxalic acid 0.5490 grm. Di_2O_3 .0.5410 grm. gave 0.4465 grm. Di_2O_3 .

In per cent—

				Calculated.	
Di_2O_3 ..	82.58	82.53	166	82.59	
B_2O_3 ..	(17.42)	(17.47)	35	17.41	
	100.00	100.00	201	100.00	

Specific gravity—

0.9074 grm., $t^\circ 15^\circ$ sp. gr. 5.680.

0.9024 " " " 5.721.

Mean of both determinations, 5.700.

Molecular volume, 35.3.

* Presented to the Royal Society of Sciences of Upsala, March 20, 1885.

Anhydrometaphosphate of Didymium, $\text{Di}_2\text{O}_3 \cdot 5\text{P}_2\text{O}_5$.

Anhydrous sulphate of didymium was added to melting metaphosphoric acid and heated to redness. The resultant mass, treated with water, left a heavy violet powder, consisting of well-formed microscopical, tabular crystals of the same form as the corresponding salt of samarium. The salt is insoluble in acids.

0.6213 grm. was fused with a mixture of carbonate of sodium and potassium, and the fused mass treated with water. The solution, filtered from insoluble residue, gave 0.5236 grm. $\text{Mg}_2\text{P}_2\text{O}_7$. The insoluble residue was dissolved in nitric acid, and the didymium precipitated with oxalic acid. The Di_2O_3 obtained by ignition of the oxalate weighed 0.1991 grm. The filtrate from the oxalate of didymium gave 0.1364 grm. $\text{Mg}_2\text{P}_2\text{O}_7$, the total $\text{Mg}_2\text{P}_2\text{O}_7$ being therefore 0.6600 grm.

0.4038 grm. gave 0.1284 grm. Di_2O_3 .

In per cent—

				Calculated.	
Di_2O_3	..	32.05	31.80	166	31.86
P_2O_7	..	67.95	—	355	68.14
		100.00		521	100.00

Specific gravity—

1.2324 grms., $t^\circ 18.4^\circ$, sp. gr. 3.333

1.8311 " " " 3.358

Mean of both determinations, 3.345.

Molecular volume, 155.8.

Carbonate of Didymium, $\text{Di}_2\text{CO}_3 + 8\text{H}_2\text{O}$.

A vessel in which some basic nitrate of didymium was suspended in a solution of nitrate of didymium, containing some nitrate of ammonium, was left for several months exposed to the air at a temperature from 10° to 15° . By this time tolerably large tabular crystals (4 to 5 millim. in diameter) and scales of nacreous lustre and violet colour had been deposited. They were washed free from the basic nitrate, and were found to consist of carbonate of didymium.

0.4274 grm., pressed between filter-paper, was heated, and left 0.2331 grm. Di_2O_3 .

0.5033 grm. was heated together with bichromate of potash in a current of dry air, and gave 0.1194 grm. H_2O and 0.1083 grm. CO_2 .

In per cent.

				Calculated.	
Di_2O_3	..	54.54	54.61	332	54.61
CO_2	..	21.52	21.71	132	21.71
H_2O	..	23.72	23.68	144	23.68
		99.78		608	100.00

Specific gravity—

0.8456 grm., $t^\circ 15^\circ$, sp. gr. 2.850

0.5142 " " " 2.872

Mean of both determinations, 2.861.

Molecular volume, 212.5.

Crystalline form. The carbonate is, according to the determinations of Mr. C. Morton, rhombic and isomorphous with *lanthanite*.

$$a : b : c = 0.95617 : 1 : c.$$

$$\text{Planes} : oP ; \infty P ; \infty \bar{P} \infty.$$

The plane of the optical axes is, as on the *lanthanite*, parallel to $\infty \bar{P} \infty$. One of the bisectrices of the optical axes goes out on the basic plane.

(To be continued).

ON ANHYDROUS CERIUM CHLORIDE AND SILICATE.

By M. P. DIDIER.

In a former communication I described the action of hydrogen sulphide upon anhydrous cerium chloride. I am about to indicate a process for preparing this body, and to describe certain other compounds which may be obtained by its means in the dry way. In preparing anhydrous cerium chloride, Mosander decomposed the sulphide with chlorine, a process which has long been abandoned. It was found preferable to fuse the hydrated chloride obtained by double decomposition with ammonium chloride to prevent oxidation. This method is used with magnesium chloride.

It is more advantageous to transform ceroso-ceric oxide directly into the anhydrous chloride. For this purpose the author causes a very dry mixture of chlorine and carbon monoxide to act upon this oxide in a boat of carbon at a very high temperature. The boat is allowed to cool in the carbon oxychloride which fills the porcelain tube employed, and the anhydrous cerium chloride is then withdrawn in the form of a crystalline mass, colourless or of a slight amber colour.

This chloride is easily fusible, but very slightly volatile. It quickly attracts moisture from the air and deliquesces. It dissolves in water with a strong liberation of heat, leaving no residue of oxychloride. Its composition corresponds to the formula CeCl , if we take $\text{Ce} = 47$.

Oxygen decomposes it at a dull red-heat, liberating chlorine, and producing ceroso-ceric oxide. If sodium chloride has been previously added to the cerium chloride the oxide produced forms crystals apparently belonging to the cubic system, of a metallic aspect, and of a bright red colour if they have been prepared at a high temperature. These crystals are identical with those obtained in another manner by M. Grandeau.

Watery vapour acting at an elevated temperature likewise transforms cerium chloride into oxide, driving off hydrochloric acid. But if its action is moderated by causing it to pass, carried by a current of nitrogen over a mixture of cerium and sodium chlorides, the sole product is the oxychloride $\text{Ce}_3\text{O}_2\text{Cl}$. This body, which is separated from sodium chloride by mere washing with water, appears in the form of micaceous, iridescent scales, of a silvery lustre. It may be obtained in an amorphous state in solution in fluxes, when it has a slightly violet colour. It is easily formed whenever an oxide of cerium and hydrochloric acid, or cerium chloride and watery vapour, come in contact at a high temperature. If oxygen intervenes oxide is also produced. This fact explains why the oxychloride, obtained by several chemists, has been described so differently. It may, indeed, have been found mixed with larger or smaller proportions of oxide.

Dilute acids readily dissolve cerium oxychloride. If heated in the air it gives off hydrochloric acid, and is transformed into ceroso-ceric oxide. Its composition agrees very exactly with the formula assigned to it.

In the course of the foregoing experiments the author has remarked that the portions of the porcelain tubes employed which came accidentally in contact with melting cerium chloride were attacked, and became covered with crystals insoluble in water and containing silica. He has been thus led to study methodically the action of silica upon cerium chloride.

On heating a mixture of these two bodies containing cerium chloride in excess in a platinum vessel and in an atmosphere of little oxidising power, a great part of the silica passes into the state of silicon chloride, and is volatilised. It is found again in the state of silica in the parts most distant from the source of heat, if the operation is conducted in a porcelain tube.

There remain in the boat, along with the excess of cerium chloride, long colourless needles, insoluble in water,

and acting upon polarised light. They are formed of cerium chloro-silicate, $\text{SiO}_2, 2\text{CeO}, 2\text{CeCl}$. This body suffers little change in water, but turns rapidly brown in the air, becoming peroxidised, as is found by the development of chlorine which is then produced by hydrochloric acid. It is intimately mixed with tablets of the oxychloride just described.

To avoid the almost total transformation of the silica into silicon chloride it is necessary to diminish the proportion of cerous chloride. But as the mass is then not sufficiently fusible to permit the crystallisation of the products of the reaction, it is convenient to substitute the oxychloride for the chloride and to make use of a flux, such as sodium or calcium chloride. By operating in this manner the author has obtained a well-defined cerium silicate. It crystallises in prisms which act energetically upon polarised light and which are bipyramidal or presenting numerous modifications, very analogous in aspect to the crystals of peridot. They are easily separated from the flux by lixiviating the mass with acidulated water. Their density is about 4.9. Some of these crystals are coloured green by traces of iron. Hydrochloric, sulphuric, and nitric acids attack them more or less rapidly according to their degree of strength. On analysis they are found to contain 2 equiv. cerous oxide to 1 of silica. Hence their composition is $\text{SiO}_2, 2\text{CeO}$, which is analogous to that of peridot. It would be interesting to compare, especially from an optical point of view, this artificial product with the complex silicates constituting cerite and cererite. This investigation the author proposes to undertake.—*Comptes Rendus*, ci., p. 882.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING OCTOBER 31ST, 1885.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner*,
Metropolis Water Act, 1871.

London, November 5th, 1885.

SIR,—We submit herewith the results of our analyses of the 189 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from October 1st to October 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in all the samples submitted to analysis.

Of the 189 samples examined, the whole were found to be perfectly clear, bright, and well-filtered.

The proportion of organic matter present in the water supplied during the month of October, though slightly in excess of that characterising the supply of the past three months, was found to be very small, and exceptionally small in view of the season of the year and of the swollen state of the river. The average proportion of organic carbon in the Thames-derived supply of the month was

0.128 part, and the maximum proportion in any one sample 0.145 part in 100,000 parts of the water, as against an average of 0.119 part, and a maximum of 0.146 part, for the preceding three months. In respect to state of aëration, and degree of freedom from colour, and from any trace of turbidity, the quality of the water supplied by all the seven Companies was unexceptionable.

We are, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

QUALITATIVE DETECTION OF FATTY OILS IN MINERAL OILS.

By F. LUX.

If ordinary rape oil is heated with potassium, sodium, or solid potassium or sodium hydroxides saponification ensues, which is in general promoted by agitation. At the temperature of 100° , and a time of action of about thirty minutes, there is formed in case of potassium, sodium, and sodium hydroxide some flocculent soap-like matter; the oil, on cooling, remains mobile. Potassium hydroxide occasions no change.

If the oil is heated for thirty minutes to 150° potassium and sodium occasion the formation of a soapy matter, and the oil remains thin on cooling. Potassium hydroxide yields a plentiful flocculent deposit which thickens the oil. With sodium hydroxide there is little deposit, a part of the soap formed dissolving in the oil, which thus begins slightly to gelatinise.

If the mixture is heated for twenty minutes to 200° the potassium is more thickly covered with flakes of soap, the oil remains liquid; sodium is similarly coated, and at the same time the oil begins to gelatinise on cooling. With the hydroxides there is abundant saponification, and the oils on slightly cooling congeal to turbid, tough masses.

If submitted to a temperature of 250° rape oil gelatinises perfectly, even in five minutes, alike with potassium, sodium, and their oxides. The soap as it is formed dissolves at once, and the globules of potassium and sodium retain a metallic lustre. In fifteen minutes the saponification has progressed further, whilst in case of potassium, sodium, and potassium hydroxide there sets in an incipient decomposition, which is recognised by the darkening and even browning of the oil. The oil which is in contact with these three agents congeals to a brown butter-like mass. Oil in contact with sodium hydroxide congeals to a hard yellowish white mass which does not darken.

Pure mineral oils, if treated in a similar manner, turn, as a rule, rather darker, but undergo no perceptible change in their state of aggregation.

Upon these observations the author founds a process for detecting admixtures of mineral oils with fatty oils. Forty series of experiments were made to test the method, the materials used being rape, linseed, and olive oils, with ordinary petroleum and two distinct lubricating oils. One of these latter, (A), was thick, opaque, of a deep blackish-brown colour, and a specific gravity of 0.915 at 15° ; it contained 35 per cent of hydrocarbons boiling below 350° . The other (B) was moderately thick, transparent, of a light brownish-yellow colour, and had the specific gravity 0.905 at 15° . It contained only 4 per cent of oils boiling below 350° .

These oils were tested in various mixtures at different temperatures and for different times and otherwise under different conditions, and with the following results:—

1. The most suitable temperature is about 200° , and the most suitable time about fifteen minutes. At temperatures below 200° the saponification proceeds more

slowly, whilst above 200° there begins a gradual decomposition of the soap which has been formed so that small quantities of fatty oil may escape notice. Fifteen minutes are necessary for very small quantities of fatty oils, but they are quite sufficient, with larger quantities (from 10 per cent upwards) from two to five minutes are sufficient.

2. Of the alkaline metals and their hydroxides the most suitable is sodium hydroxide, and after this metallic sodium. The latter is more suitable for the detection of small quantities of fatty oils in mineral oils which contain a large proportion of hydrocarbons boiling below 350°, as the anhydrous soap formed on its use dissolves more readily in the volatile hydrocarbons than the hydrated soap formed from sodium hydroxide, which, at the temperature of 200° is more apt to separate out in flocks than to dissolve in the oil.

3. To detect with certainty small quantities of fatty oil it is better to avoid all stirring or shaking both during heating and cooling. On the one hand the currents produced by heating suffice to bring all parts of the oil in contact with the sodium or the soda and to distribute the soap which has been formed in the entire liquid. On the other hand the soapy matter, formed when at rest, remains more in connection, the jelly is more coherent and tougher, whilst on shaking there is formed a more finely grained and flowing jelly which is with difficulty distinguished from the real liquid. In a transparent oil this half gelatinised state is more readily observed than in an opaque oil.

4. Even during the heating it is possible to decide with a high degree of probability whether a mineral oil is free from fatty oils or not. If the fatty oil is more than 10 per cent the characteristic odour of soap appears very distinctly during heating and remains after cooling. The little bubbles of gas or air which escape from the soda or the sodium and rise to the surface disappear at once in pure mineral oils. But if fatty oil is present they remain for some time, as a rule even after cooling, since they are rendered somewhat coherent by the soap which is formed. In transparent oils this phenomenon is more easily observed than in opaque ones, in the former case with a percentage of even $\frac{1}{4}$ per cent of fatty oil.

5. If in these experiments we make use of ordinary test-tubes of 15 to 25 m.m. in diameter there is formed on cooling, at the surface of mineral oils mixed with fatty oils, distinctly perceptible funnel-shaped depressions.

6. The gelatinisation of mineral oils containing fatty oils takes place at rather high temperatures. Thus an American petroleum containing 10 per cent of rape oil congeals at 190°, with five per cent at 170°, and with 2 per cent at 130°. These temperatures can be determined only approximately, as the transit of a body from the liquid to the gelatinous state takes place very gradually, not within sharply defined limits like the transition of a body from the liquid to the solid state. Hence, enticing as the prospect may seem at the first glance, it will scarcely be possible to found a method for the determination of the fatty oils upon the observation of the gelatinising-point.

7. The limits of the detectibility of fatty oils in mineral oils are not the same for all mineral oils (and perhaps also not for all fatty oils), but with all the combinations of the oils above mentioned a proportion of 2 per cent of fatty oil can be shown with absolute certainty either by means of caustic soda or sodium.

The following method is therefore founded on the basis of these results:—

A. Preliminary experiment, or method for the detection of large quantities of fatty oil, 10 per cent and upwards.

Pour 5 c.c. of the sample into a test-tube and add a fragment of caustic soda, heat to a boil over the naked flame, and keep it at that temperature from one to two minutes. If large quantities of fatty oil are present they are recognised by the peculiar odour, and certainly by the coagulation of the liquid which ensues on slight cooling.

As if fatty oil is present its quantity is rarely less than

10 per cent, the investigation will generally be herewith concluded, *i.e.*, if the result is affirmative. If it is negative we pass over to

B. Detection of smaller quantities of fatty oils, down to 2 per cent.

We take two beakers of moderate size, one of which can be inserted in the other, so as to leave a distance of 1 to 2 c.m. between their bottoms. In the larger is put so much melted paraffin that when the narrower glass is inserted the paraffin rises a little more than half height in the narrow annular space between the two. Into the inner glass is then poured so much paraffin that the two bodies of liquid rise approximately to the same height. In this manner there is obtained a paraffin bath, in which an over-heating of the liquids contained in the test-tubes, such as there might occur in a single beaker, is rendered impossible, whilst at the same time a perfect observation of the behaviour of the oil is rendered practicable. A thermometer suspended in the inner beaker shows the temperature, which is kept at about 200° to 210°.

Two test-tubes receive each a few c.c. of the oil in question. To one are added a few parings of sodium, and to the other a rod of caustic soda, which must be about 1 c.m. beneath the surface of the oil. The two test-tubes are then inserted in the paraffin-bath, and the time is noted. They are left at rest in the bath for fifteen minutes, lifted out, wiped clean from the adhering paraffin, and placed to cool.

If the mineral oil in question contains even as little as 2 per cent of fatty oil, it congeals on cooling in one or in both tubes—generally in both—to a more or less cohesive jelly. The test-tubes may then be inverted without anything escaping, and only on strong shaking are portions of the gelatinous mass detached.—*Zeitschrift f. Analytische Chemie.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, November 19th, 1885.

Dr. HUGO MÜLLER, F.R.S., President, in the Chair.

CERTIFICATES were read for the first time in favour of Messrs. Robert G. Christopher, 35, Chantler Road, Custom House, Victoria Docks; William J. Cousins, 12, Maude Grove, West Brompton, S.W.; Andrew Thomson, 3, Viewforth Place, Dundee; William Watson Will, Ossory Villa, Ossory Road, S.E.; William Matthew Wilson, Bedford Cottage, Harpenden.

The following were elected Fellows of the Society:—Messrs. William James Bell, B.A.; Gibson Dyson; William Herbert Hyatt; Albert Ivatt; Gerald Martin; Thomas J. Menzies; Edward de Souza; J. Dominie Vieira; Herman T. Vulté, Ph.B.; Ernest William Wiltshire; Arthur Benjamin Winstone; T. G. Wormley; James C. Wright.

The following papers were read:—

70. "Aluminium Alcohols. Part III. Aluminium Orthocresylate and its Products of Decomposition by Heat." By J. H. GLADSTONE, F.R.S., and ALFRED TRIBE.

Aluminium para- and metacresylate and their products of decomposition by heat have been previously described by the authors. They now give an account of the preparation of aluminium orthocresylate. As obtained, it consisted of a black vitreous mass, readily soluble in benzene, and decomposed by water.

The distillate obtained by heating it in a flask fitted with a wide bent tube was divided by fractionation into

three portions: (a) boiling between 140° and 200° , (b) boiling between 200° and 300° , and (c) boiling above 300° . Fraction *a* was found to consist almost wholly of the original substance. From fraction *b* a body was obtained which is shown to have the molecular formula $C_{14}H_{14}O$. From the properties and mode of formation of this body it is concluded that it is orthocresylic ether, thus completing the series of ethers corresponding to the three isomeric cresols. From fraction *c* a small quantity was isolated of a body crystallising in diamond and star-shaped plates, and of a composition agreeing with the formula $C_{15}H_{14}O$. From the general properties and mode of formation of this body the conclusion is drawn that it is isomeric with the "ketones" previously described.

The isomeric cresylates furnish very different amounts of distillate and of "ketone":—

	Distillate from 1000 parts.	Solid from 1000 parts.
Aluminium paracresylate ..	609	106
Aluminium metacresylate ..	640	20
Aluminium orthocresylate ..	475	2·5

The temperatures at which the destructive distillation of the several aluminium cresylates takes place are very different, this being more especially noticeable in the case of the para- and ortho-modifications. Besides probably accounting for the difference in the amounts of product obtained, this observation is of interest as showing that a difference exists in the stability of these aluminium isomerides.

71. "Notes on the Constitution of Hydrated and Double Salts." By SPENCER U. PICKERING.

Various attempts have been made to examine the differences in the individual molecules of water in a hydrated salt, amongst which Thomsen's determination of their heat of combination stands pre-eminent. The difference of the heat of dissolution of two hydrates such as $MgSO_4 \cdot 3H_2O$ and $MgSO_4 \cdot 4H_2O$ was assumed by him to give the heat of combination of the 4th water molecule, and so on; this is based on what the author believes to be a groundless assumption that the three molecules already combined are not in any way influenced by the addition of the fourth molecule: it would be as rational, he thinks, to argue that the energy with which an atom of lead is combined with one of sulphur in PbS remains unaltered after the absorption of oxygen to form lead sulphate. We have no reason for assuming that the energy with which several molecules cling together is not influenced by the addition of a fresh one, nor have we as yet any grounds for assuming that all the various water molecules in a hydrated salt are not precisely similar. The few arguments which may be brought to bear on the question all favour the opposite view.

The fact that one molecule of water in the magnesian sulphates is retained at a higher temperature than the others is no more a reason for regarding it as differing, either in nature or degree, from the rest than would the retention of one atom of oxygen in hydrogen dioxide at a much higher temperature than the other be a reason for regarding the two oxygen atoms in this compound to be differently combined. The constitutional molecule theory has no *raison d'être*.

The accurate reproduction of the characteristics of copper and magnesium sulphates in the double salts which they form with potassium sulphate would lead to the conclusion that they are simple displacement products, $MgSO_4 \cdot K_2SO_4 \cdot 6H_2O$ being similar to $MgSO_4 \cdot 7H_2O$ —so-called molecular compounds. This view is favoured by the fact that the specific heat of the anhydrous α -copper salt—that one which is obtained from the hydrated salt at the lowest possible temperature—is very nearly equal to the sum of the specific heats of the component sulphates, just as the specific heat of a hydrated salt is equal to the sum of the specific heats of the anhydrous salt and solid water.

The determinations gave—

α - $CuK_2(SO_4)_2$ molec. sp. heat..	56·025
β - " " " " ..	51·240
γ - " " " " ..	58·735
$CuSO_4 + K_2SO_4$ " " " " ..	54·460

the last being somewhat low owing to experimental difficulties. As heat is developed in the passage of the α - into either the β - or γ -modifications, it is probable that the elements constituting these are more intimately combined than they are in the α -modification.

Although the heat of combination of $CuSO_4 + K_2SO_4$ is much smaller than $CuSO_4 + H_2O$, when the fully hydrated salts are considered it is seen that the double salt in crystallising out will evolve a larger amount of heat than the two sulphates would separately.

The tendency, as measured by the heat developed, of the α - to pass into the β -modification increases, and of the α - to pass into the γ -modification decreases, with the temperature. The formation of the γ -modification, therefore, as the temperature is raised, with an absorption of heat, is a good instance of the insufficiency of Berthelot's principle of maximum work to explain all chemical reactions.

DISCUSSION.

Professor RAMSAY said that it would perhaps be worth while to repeat Hannay's experiments on the rate at which water was lost by hydrated salts. He believed that Hannay had found that the rate was fairly constant as long as water of a certain kind was given off, and changed when water of another kind was expelled. It would be interesting to know whether the $6H_2O$ in the double sulphates was lost at the same rate as the $6H_2O$ in magnesium sulphate.

Mr. PICKERING replied that he had carefully studied Hannay's work and had corresponded with him. The breaks referred to were not well defined; in fact, he thought the experiments did not afford any very definite evidence.

72. "Some New Vanadium Compounds." By J. T. BRIERLEY.

If a blue solution of hypovanadic sulphate be mixed with a colourless solution of an alkaline metavanadate a dark green liquid results, and if a slight excess of sodium hydroxide be added to this, the colour quickly changes to a deep black. Well-defined crystalline salts, having a purple or dark green colour and metallic lustre, can be obtained from this dark solution. The following five are described:—

1. $2V_2O_4 \cdot V_2O_5 \cdot 2Na_2O \cdot 13H_2O$, soluble.
2. $2V_2O_4 \cdot V_2O_5 \cdot 2K_2O \cdot 6H_2O$, soluble.
3. $2V_2O_4 \cdot 4V_2O_5 \cdot 5K_2O \cdot H_2O$, insoluble.
4. $2V_2O_4 \cdot 2V_2O_5 \cdot (NH_4)_2O \cdot 14H_2O$, soluble.
5. $2V_2O_4 \cdot 4V_2O_5 \cdot 3[(NH_4)_2O] \cdot 6H_2O$, insoluble.

By gently igniting the ammonium salt No. 5, a dark green oxide is obtained, which readily absorbs moisture from the air, forming the hydrate $3(V_2O_4 \cdot V_2O_5) \cdot 8H_2O$.

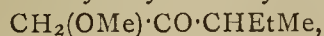
When the black oxide V_2O_3 is allowed to stand exposed to the air for many months it absorbs oxygen and moisture, its colour changing to a light grass-green: analysis of such a product gave results agreeing with the formula $V_2O_4 \cdot 2V_2O_5 \cdot 8H_2O$; it dissolved in dilute sulphuric acid, and on neutralising the solution with potassium hydroxide and heating, the insoluble potassium salt No. 3 was obtained.

73. "On the Action of PCl_5 upon Ethylic Diethylacetate." By J. W. JAMES.

Geuther has shown that when ethylic acetoacetate is heated with PCl_5 , ethoxyl becomes displaced by chlorine, two isomeric chlorocrotonic chlorides being formed. Rücker obtained a similar result with ethylic methylacetoacetate, the product being a single methylchlorocrotonic chloride. The author finds that ethylic diethyl-

acetoacetate behaves differently, the chief products being a mono- and a di-chlorinated derivative; what appears to be an ethylchlorocrotonic chloride is also formed in small quantity.

The diethylmonochlor- and dichlor-acetoacetates are converted into corresponding methoxy-derivatives on careful treatment with sodium methoxide. If an excess of methoxide be employed the diethylmethoxyacetoacetate is converted into methylethylmethoxyacetone,—



a somewhat abnormal decomposition.

Ethyl diethylmethoxyacetate behaves normally in presence of excess of methoxide, and is converted into diethylmethoxyacetone, $\text{CH}(\text{OMe})_2\cdot\text{CO}\cdot\text{CHEt}_2$.

Ethyl diethylacetoacetate is not acted upon by aqueous ammonia at 120° to 130° , and at 190° to 200° is converted into diethylacetone: its behaviour in this respect is therefore also different from that of ethyl acetoacetate.

74. "On the Vapour-pressures of Mercury." By W. RAMSAY, Ph.D., and SYDNEY YOUNG, D.Sc.

After criticising Regnault's determinations of the vapour-pressures of mercury, the authors show that his results do not agree with the following generalisation, which has been proved to be true in twenty-two instances.

A relation exists between the absolute temperatures of all bodies, whether solid or liquid, whether stable or dissociable, which may be expressed in the case of any two bodies by the equation—

$$R' = R + c(t' - t),$$

where R is the ratio of the absolute temperatures of the two bodies corresponding to any vapour-pressure, the same for both; R' is the ratio at any other pressure, again the same for both; c is a constant which may equal 0, or a small plus or minus number; and t' and t are the temperatures, absolute or centigrade, of one of the bodies corresponding to the two vapour-pressures. When $c=0$, $R'=R$, or the ratio of the absolute temperatures is a constant at all pressures; and when $c>0$ or $c<0$, its values may readily be determined either by calculation, or graphically by representing the absolute temperatures of one of the two bodies as ordinates, and the ratios of the absolute temperatures at pressures corresponding to the absolute temperatures of that body as abscissæ. It is found in all cases that points representing the relation of the ratio of the absolute temperatures of the two bodies to the absolute temperatures of one of them lie in a straight line.

From this it follows that if the vapour-pressures of any one substance are known throughout, it is sufficient to determine accurately the vapour-pressures of any other substance at any two temperatures, sufficiently far apart, in order to be able to construct its whole vapour-pressure curve.

The vapour-pressures of mercury have accordingly been measured with the greatest care at the temperatures:— 222.15°C ., 270.3° , 280.2° , 447° , and 448° .

On comparing the ratios of the absolute temperatures of mercury and water, at pressures corresponding to those temperatures, they are found to agree with the equation $R'=R+c(t-t')$, where $c=0.0004788$, if the temperatures of mercury be chosen as ordinates.

It is therefore possible to construct the complete vapour-pressure curve of mercury: the paper contains tabular statements of the values.

At the next meeting, on December 3rd, there will be a ballot for the election of Fellows, and the following papers will be read:—

"The Sugars of the Cereals, and in Malted Grain"; "On the Presence of 'Raffinose' in Barley." By C. O'Sullivan, F.R.S.

"On the Evidence of Constitution afforded by Absorption-Spectra." By Captain Abney, F.R.S.

NOTICES OF BOOKS.

Smoke Abatement: Prize Essays on the subject of "How best to Utilise Gaseous Fuel and Coke for Domestic and Industrial Purposes with the view to Abate Smoke in Towns." Reprinted from *Gas and Water*. London: John Allan.

We shall not, it is to be hoped, seem to be in love with the smoke nuisance or indifferent to its abatement if we point out that the essayists whose writings are before us do not fully realise the most objectionable feature of our present consumption of coal. Soot, "blacks," and the other visible matters which make up smoke, according to the popular notion, are bad enough. But the worst of the gaseous products of the combustion of coal is sulphurous acid, derived from the oxidation of the sulphur present, more or less, in all coal. It is this acid which blights vegetation in and around our cities, which corrodes articles of metal, leather, paper, &c., exposed to its influence, discharges the colours of dyed and printed tissues, and even eats into the very stones of our buildings. The quantity of the sulphurous acid thus poured into the air of Britain is something fearful, as has been ably shown by the late Peter Spence, of Manchester. Few samples of coal contain less than 1 lb. of sulphur per ton in the shape of pyrites, whilst many kinds contain 1 lb. per cwt. For every ton, therefore, of coal burnt we have even in the best cases a production of 2 lbs. of sulphurous acid. This, in contact with moist air, becomes further oxidised, yielding sulphuric acid equal to 3 lbs. of oil of vitriol.

Now, unfortunately, the remedies proposed by Messrs. Somerville, Folkard, and Whimster, even if universally carried out, would fail to touch this evil. Coke and anthracite give off when burning little or no visible smoke, but everyone knows that they are not free from sulphur, and that in this respect they pollute the atmosphere just as does bituminous coal. What is known as "smoke-consumption," which is in use in many factories, but which, to do them justice, the essayists do not propose to enforce upon the domestic consumer, merely guarantees that every grain of sulphur existing in the coal shall be converted into its equivalent of sulphurous, and ultimately of sulphuric, acid. Gas, also, whether ordinary or "consumer's," is never free from sulphur. To abate the domestic production of smoke, the only really efficient way is to minimise the consumption of fuel. In other words, we must abandon the open grate used for warming our rooms in favour of earthenware stoves, such as are used in most parts of the Continent. By so doing we should not only economise three-fourths of the household consumption of coal, and consequently of the production of smoke, but we should secure a more equable temperature in our dwellings. Lastly, we should probably give a deadly blow to the "coal-ring." The arguments against the tiled stove, drawn from the variable character of our long winters, are of little value; but there is no necessity to keep such a stove in action during the entire day, except the weather be very severe. Unless the temperature remains below 0° in the daytime, it is generally sufficient to fire up in the morning, let the stove die out towards noon, and heat again in the evening. In these days, when so many old customs and institutions are not merely called in question but even abandoned, it can hardly be supposed that the "cheerful" fire should prove impregnable.

For cooking, &c., gas-stoves may of course be used; but why does Mr. Folkard seek to depreciate the use of mineral oil-stoves? If it be desirable to economise our coal-supply—which no one doubts—it is surely good policy to bring petroleum and paraffin into play. There are now petroleum-stoves to be had which give full satisfaction for culinary uses, which give off no vapours of sulphur if a fair quality of oil is employed, and which have the great advantage of being removable at pleasure.

The same writer makes a proposal which in these days of declining trade and diminishing incomes is unsurpassed for its coolness. In order that gas may be sold at a reduced figure he proposes to levy a rate of 1s. to 2s. in the pound! Surely the rate-paying powers of the public are in most towns well-nigh exhausted.

Mr. Whimster states that:—"The public generally are under the impression that increased pressure of gas is necessary, and that they could not get their appliances (*i.e.*, gas-stoves) to act satisfactorily with the ordinary pressure prevailing in most towns during the hours of daylight. *Of course this is a great mistake.*" Begging Mr. Whimster's pardon, it is no such thing. That the pressure at gas-works is reduced in the daytime will not, we suppose, be denied. And if any incidental occurrence increases the demand by day the supply proves deficient. In foggy weather, when the gas was very generally lighted in offices and shops, we have more than once been unable to effect a determination of nitrogen in a gas-furnace, and have been obliged to seek up an old Liebig's charcoal furnace. Now what would be the result if in half the houses of a town cooking operations were being carried on? Spoiled dinners, unless the gas manufacturers increase their pressure.

To sum up, we fear that coke and coal-gas, as they fail to diminish the production of sulphurous acid, cannot be regarded as the keys of the situation. As such—at least in as far as dwelling-houses are concerned—we should consider the German stove for warming and the petroleum stove for cooking.

The Paper-Makers' Directory of all Nations. (Internationales Address-Buch saemtlicher Papier Fabrikanten der Welt. L'Annuaire de la Papeterie des toutes les Nations.) Containing every Paper- and Pulp-Mill in the World. Edited and Compiled by S. CHAS. PHILLIPS. London: *Paper-Makers' Circular Office*, 19, Cursitor Street, E.C.

This useful work of reference is provided with a trilingual title and with three prefaces, written respectively in English, German, and French. The last mentioned seems to have suffered somewhat at the hands of the printer. Thus we read of ambassadors and consuls "qui eurent l'extrême *haute* de nous prêter leur appui." We presume the word intended is *bonté*. Again—"Les corrections et les surcroits sont immenses et peuvent *exisément* être observés en comprenant les deux volumes." The index is trilingual, and advertisements appear in various tongues. The body of the work, however, is drawn up in English in as far as it embraces matter other than mere names and addresses, such as, for instance, the kinds of goods manufactured at each mill, the number of machines, &c.

The Paper-Makers' Directory must prove very useful as a book of reference to makers of alkali, bleaching-powders, colours, and, in fact, to chemical manufacturers generally.

The Essentials of Materia Medica and Therapeutics. By A. BARING GARROD, M.D., F.R.S. Eleventh Edition. Revised and Edited by NESTOR TIRARD, M.D. (London). London: Longmans, Green, and Co.

WHEN a work has, like the one before us, passed through the ordeals involved in eleven successive editions, and still retains the confidence and the approbation of the class to whom it is addressed, the scope for the critic is indeed minimised. The chief points to be noticed in the present issue of Dr. Garrod's work is the manner in which it has been brought to the present level of knowledge. Much new matter has been necessarily inserted to bring the book into harmony with the new "British Pharmacopœia" of the present year. On the other hand, the notices of drugs now obsolete or obsolescent have been abbreviated or expunged entirely. The section on Therapeutics has been modified, and the notice of mineral

waters, now so much in vogue, has been re-written in accordance with modern views. The chemistry of the work has undergone a careful revision, though the peculiar terminology depending on the use of Latin as the language of prescriptions is of course still retained.

The Extra Pharmacopœia, with the Additions introduced into the British Pharmacopœia, 1885. By W. MARTINDALE, F.C.S. Medical References, and a Therapeutic Index of Diseases and Symptoms. By W. WYNN WESTCOTT, M.B. (Lond.) London: H. K. Lewis.

THIS little work, which has now reached its fourth division, is found to be of great value both to medical practitioners and to pharmacists. In the preface the authors, not unjustifiably, express a regret that working medical men and practical pharmacists were not allowed to have any voice in the elaboration of the new British Pharmacopœia, and they point out certain oversights which the co-operation of such men would have rendered impossible. To any person trained in pure, or even in technical, chemistry, the quasi-Latin terminology still used by pharmacists has a strange, old-world appearance. At the same time we must admit that the nomenclature used by German physicians and apotheker is still more exceptionable. Mr. Martindale regrets that the so-called decimal system of weights and measures has not been adopted in the new Pharmacopœia. At the same time he objects to the practice of weighing liquids in dispensing medicines as followed in Continental states. This method involves of necessity a sacrifice either of time or of accuracy. He states, further, that in Germany the quantities of the ingredients are written in decimal proportions, the unit, understood though not expressed, being the gramme. Thus 35· would mean 35 grammes of any substance, whilst ·035 stands for 35 milligrammes. We think this greatly open to objections, since the accidental misplacement, omission, smudging, or non-observance of a decimal point would completely modify a prescription. We regret to find the utterly un-English term "fuchsine"—unpronounceable by an Englishman who does not speak German, and wrong in principle, like its congeners azaleine, harmalene, &c.—still retained. We have a far better trivial name, magenta; or, if a strictly scientific terminology be preferred, why not say rosaniline hydrochlorate or acetate, as the case may be. The author, commenting on certain changes of nomenclature made to agree with the theories of modern chemists, expresses a hope that these changes may be final. We are less sanguine. Changes of nomenclature give an excuse for a brood of new text-books.

Pennsylvania Pharmaceutical Association. Proceedings, 1885, with the Constitution, Bye-laws, Code of Ethics, and Roll of Members.

A GREAT part of the matter here is merely of local interest. In a report on adulteration we find it stated that ammonium chloride showed excess (?) of iron and carbonaceous matter; potassium bromide contained an excess of chlorides, carbonates, and moisture; potassium iodide had excess of chlorides, bromides, iodate, sulphate, and alkali. Yellow bees'-wax, in irregular pieces, as if supplied by country bee-keepers, has been found to contain 75 per cent of paraffin. Antimony sulphide is sold composed principally of coal-dust, and "probably does not contain a grain of antimony." Commercial Castile soap is "heavily loaded with barytes," probably barium sulphate.

Composition and Fermentation of Invert Sugar.—E. Bourquelot.—The author maintains, in opposition to M. Maumené, that invert sugar consists of equal proportions of glucose and levulose. As against M. Leplay he holds, in agreement with M. Maumené, that there is no such thing as elective fermentation.—*Comptes Rendus.*

CORRESPONDENCE.

THE HELL-GATE EXPLOSION NEAR NEW YORK, AND "RACKAROCK."

To the Editor of the Chemical News.

SIR,—Your issue of October 30 (CHEM. NEWS, vol. lii., p. 215), contains a communication from Dr. H. Sprengel in reference to the explosives used at the Hell-Gate blast on October 10.

Dr. Sprengel considers himself to be the discoverer of that class of explosive compounds, and I do not doubt that he made his invention without knowledge of what I had done.

I enclose a certified copy of my caveat, filed January 9, 1871, in the United States Patent Office, to show that my record ante-dates his, and I know that my invention being prior was made independently of his.—I am, &c.,

S. R. DIVINE.

Rendrock Powder Company,
23, Park Place, New York,
November 13, 1885.

(CAVEAT).

"The petition of Silas R. Divine, of the city of Brooklyn, of the county of Kings and State of New York, respectfully represents:

"That he has made certain improvements in explosive compounds for blasting rocks and for other purposes, and that he is now engaged in making experiments for the purpose of perfecting the same, preparatory to applying for letters patent therefor. He therefore prays that the subjoined description of his invention may be filed as a caveat in the confidential archives of the Patent Office.

"The following is a description of my newly invented compounds for blasting, which is as full, clear, and exact as I am able at this time to give.

"The object of my invention is to produce powerfully explosive compounds which may be transported anywhere without danger to life or property. This I accomplish by using a material in two parts, a powder and a liquid, either of which separately is non-explosive, but which mixed with the other forms a compound that can be exploded. For this purpose I take a chlorate or perchlorate, preferring chlorate of potash, in fine powder as one ingredient, and a hydrocarbon, ether, or liquid nitro-substitution compound for the other ingredient, or such a mixture of the last-named materials as shall not be explosive without admixture with the chlorate of potash. As a safe material for the liquid ingredient I prefer nitro-benzol, or oil of myrbane, or a solution of other nitro-substitution products in nitro-benzol in such proportions as not to make an explosive liquid by itself.

"Now when we take powdered chlorate of potash and oil of myrbane and put them together, the oil of myrbane will instantly saturate the powder, and we have a semi-fluid mass which can be put in a hole in a rock and may then be exploded by a fulminating cartridge or by gun-powder after the manner of nitro-glycerine.

"The materials need not be mixed until wanted for use, and may be transported or stored separately with entire safety.

"SILAS R. DIVINE.

"PARK BENJAMIN.

"HUGH C. JOHNSTON.

"City, County, and }
State of New York. } (s. s.)

"Silas R. Divine, the above-named petitioner, being duly sworn, deposes and says that he verily believes himself to be the original and first inventor of the improvement in explosive compounds described in the foregoing specification; that he does not know and does not believe that

the same was ever before known or used; and that he is a citizen of the United States.

"Sworn to and subscribed before me this seventh day of January, 1871.

(L. S.)

"HEZEKIAH WATKINS,
"Notary Public,
"N.Y. City and County."

"DIDYMIUM."

To the Editor of the Chemical News.

SIR,—The recent publication in your columns of Prof. Clève's work on didymium comes at a very opportune time. It is but a few weeks since you gave an abstract from the *Chemiker Zeitung* announcing that Dr. Welsbach had separated this same element, didymium, into two distinct substances whose salts showed different absorption-spectra. The didymium Clève employed in his previous work had an atomic weight of 147, which is now known to have been contaminated with over 60 per cent of samarium.

The most characteristic test for didymium is the absorption-spectrum exhibited by its salts: roughly, this spectrum consists of a band in the yellow, two in the green, and a group of three bands in the blue region. Examining the didymia earths from samarskite, Delafontaine, in 1878, observed that the absorption-spectrum was not the same as that afforded by the didymia earths from cerite, as regards the bands in the blue. M. de Boisbaudran shortly afterwards eliminated from the samarskite earths an oxide which he named samaria, whose salts showed an absorption-spectrum of two bands in the blue, and since that time Brauner, Clève, and Crookes have separated the same oxide from cerite didymia.

Although the anomaly noticed by Delafontaine is thus explained, there is still another connected with the absorption-spectrum of didymium salts, and it is this. In the separation of samaria from didymia by fractional precipitation, the intermediate fractions, that is to say, those containing much samaria and little didymia, show the bands in the yellow and green very distinctly; but the group of three bands in the blue, also considered to belong to didymia, and almost coincident with the two bands of samaria, are very indistinct or scarcely visible. Based upon this observation, several chemists have supposed that there is yet another element associated with "didymium," or that this "element" may be in reality a mixture of two, the salts of one showing an absorption-spectrum of a band in the yellow and two in the green, the other of three bands in the blue.

Brauner, amongst others, has noticed and tried to explain this anomaly as being brought about by the combined action of the samaria and didymia (C. S. J., 1883); and Clève has distinctly stated (C. S. J., 1883) that he made a very minute search for an element lying between didymium and lanthanum, but could find no trace of one, and I can add that working on the "tail-end" of didymium for the separation of lanthanum, the spectrum always exhibited the bands of didymium, there being no apparent increase in the intensity of the three blue bands, which might have been expected if they were due to a distinct element, which, judging by the above anomaly, would have become concentrated near the lanthanum.

Now, Welsbach has made use of fractional crystallisation to effect his separation, whereas all other chemists, so far as I am aware, have employed fractional precipitation or fractional fusion in their work, methods based on the assumption that a difference exists in the basic powers of the constituents submitted to such operations. Without such a difference the processes would be valueless; for it is evident that if a solution contains two salts, the oxides being of the same basic powers with relation to a given precipitant, however small the fraction precipitated, and however widely the amounts of the two salts may

differ, the ratio of the two in the precipitate will be the same as that left in solution, and no separation would be possible by such a process.

Even if there is a difference in the basic powers, but very slight, the process of fractional precipitation may be valueless, taking the probable working life of a chemist as thirty years. For instance, if a solution contains salts of two oxides differing slightly in basic powers, and a small fraction be precipitated, the smaller this fraction the greater will be the ratio of the less basic to the more basic materials in the precipitate; that is to say, greater than the ratio of the two salts in the solution. If the basic powers be as 1000 : 1001, and the solution contain equal amounts of the two salts, the ratio of the less to the more basic material in the small precipitate will be $\frac{1001}{1000}$, or it will be richer than the solution in the less basic oxide by only $\frac{1}{1000}$ th part; but in order to obtain sufficient material to perform a second operation upon it, a very much larger quantity must be precipitated, and consequently the "richness" will be less than above. If the solution contain only 10 per cent of the less basic, the small fraction will only be enriched to the extent of $\frac{1}{1000}$ th part.

It is evident, then, that fractional precipitation as a method for separating two oxides differing but slightly in basic powers, to say the least of it, may be the work of a lifetime, even when operating upon a large amount of material. Anyone who may have succeeded in eliminating a little samaria from didymia, by fractional precipitation, or in separating the last trace of terbium from yttria, knows the labour such separations involve.—I am, &c.,

JOHN J. HOOD.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—A report has been current during the last few days that a proposal has been made to the Council of the Institute of Chemistry to do away with the examinations of the Institute—at least for a time—and to admit to the Associateship and Fellowship "on such evidence of fitness as may be satisfactory to the Council."

It is sincerely to be hoped that if this report is true—and there is good reason to think that it is—no such step would be taken by the Council without submitting the matter for the consideration of the general body of Fellows and Associates,—for it is a question affecting the status of every member and the name and position of the Institute before the Public.

In the excellent address which he delivered a few days ago, the President of the Institute, Professor Odling, again pointed out the great importance to the chemical profession of an examining body of acknowledged position. It would surely be hardly consistent with this, and hardly consistent with most other points in the address and with its general tone, to proceed to the admission of members immediately afterwards without the application of the only test which can make the membership of the Institute of any value, and the Institute itself respectable in the eyes of the public.

The case might be different if the qualification of the Institute were legally necessary for practice, but in the absence of this nothing can excuse such a proceeding as the one said to be in contemplation.—I am, &c.,

F.I.C.

On Rosolene.—Emile Serrant.—This product, otherwise known as retinol, $C_{32}H_{16}$, is obtained by the dry distillation of resin. It is in appearance like the oil of sweet almonds. It is insoluble in water and alcohol, soluble in ether, the essential oils, and carbon disulphide. It mixes perfectly with the fatty oils in all proportions, but it is incapable of saponification, or of turning rancid.—*Comptes Rendus*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 19, November 9, 1885.

On Schloesing's Law relating to the Solubility of Calcium Carbonate in Carbonic Acid.—R. Engel.—The objections taken by M. Caro to Schloesing's law are not well founded. The solubility of calcium carbonate follows sensibly Schloesing's law for pressures higher than that of the atmosphere. The differences remain always positive and augment with pressure. The approximate formula which the author has proposed to express the solubility of magnesium carbonate gives also very closely approximating values for calcium carbonate. The author has also verified Schloesing's law for barium carbonate at pressures higher than that of the atmosphere. The results are of the same order as those obtained for calcium carbonate.

Bulletin de la Société Chimique de Paris.
Vol. xlv., No. 3, Aug. 5, 1885.

Use of Kœrting's Apparatus to Improve the Draught of Pyrites Kilns and to Feed the Lead Chambers.—M. Scheurer-Kestner.—Kœrting's apparatus may be employed at the head of the first lead chamber, when the chambers are not preceded by a Glover tower; in this case their use is very economical, because the steam is utilised in the chambers. In other cases they can only be placed after the Gay-Lussac tower, and their action is much less economical, though regular and practical.

Remarks on M. Cotton's Note on the Action of Oxidisers upon Chloral Hydrate.—M. Tanret.—Carbon monoxide and dioxide are the constant products of the decomposition of chloral hydrate as well by mercury oxides and chromic acid as by potassium permanganate.

Alkaloids produced by the Action of Ammonia upon Glucose.—C. Tanret.—The author finds that not merely ammonia, but the compound ammonias, ethylamine, methylamine, &c., if heated with glucose, produce alkaloids. This reaction is also manifested, though to a less extent, with the ammonium salts of organic acids. Hence this manner of producing artificial alkaloids may throw some light on the formation of alkaloids in plants, and of the ptomaines. In the present paper the author describes the two alkaloids, α - and β -glucosine, produced by the action of ammonia upon glucose.

Composition of Terpinol.—Ch. Tanret.—It results that the ordinary formula assigned to terpinol must be rejected. The true terpinol boiling at 215° to 220° is a monohydrate of terebenthene, and that the product obtained either by the action of dilute acids upon terpinol, or by the action of alcoholic potassa upon terebenthene dihydrochlorate is merely the mixture of a carbide, $C_{20}H_{16}$, and of the monohydrate. These conclusions overturn the hypotheses based upon the old formula, especially that which regards terpinol as an ether of terebenthene monohydrate.

Direct Action of the Solar Rays upon Nitric Acid and Carbon Disulphide contained in a Tube Hermetically Closed.—M. Tiffereau.—On exposing to the direct action of the solar rays strong nitric acid and carbon disulphide in the proportion of two parts of the acid to one of the sulphide in tubes sealed at the lamp, the liquids occupying about one-fifth of the capacity of the tubes, the nitric acid is decomposed. Vapours of nitrous acid are given off, and hyponitric acid distils along with carbon disulphide into the upper part of the tube. The vapours

condense in the form of a greenish blue liquid, which runs down the sides of the tube. By degrees the entire mass of liquid turns of a greenish blue colour, and ultimately becomes black. Subsequently crystals appear, lining the upper part of the tube, probably analogous to "chamber crystals." In two of the tubes the reaction appeared to have come to a definite end. In the one there was a black deposit of carbon; in the other perfectly white crystals, apparently of a cubic form, were deposited, whilst in the lower part of the tube there remained two liquids of different specific gravity, the one slightly yellowish, and the other perfectly clear and colourless.

Reductive Properties of Pyrogallol, Action on the Salts of Iron and Copper.—P. Cazeneuve and G. Linossier.—Pyrogallol, in contact with ferric salts, reduces them to the ferrous salts, becoming oxidised itself. The constituent elements of the blue compound, oxidised pyrogallol, and a ferrous salt are thus brought in contact, but this blue compound does not appear, since it is destroyed by the acid liberated if this is energetic. The red colour perceived is that of pyrogallol, more or less oxidised. In presence of ammoniacal cuprous chloride pyrogallol does not produce any immediate colouration, if air be excluded, though in course of time metallic copper is deposited on the sides of the tube. The introduction of a bubble of oxygen provokes the development of an intense black-brown colour. With copper sulphate there is immediate reduction of the cupric salt. An alkali added develops the black colouration instantly, even if air is excluded. This colouration is reddened by an excess of ammonia and is destroyed by hydrochloric acid. In cupric acetate the black colour is produced at once without the addition of an alkali.

New Observations on the Chlorobromised Camphors; Production of Camphoric Acid.—P. Cazeneuve. This lengthy paper is not capable of useful abridgment.

Vol. xlv., Nos. 4 and 5, September 5, 1885.

Crystallographic Study of the Mono- and Bi-substituted Derivatives of Camphor.—P. Cazeneuve and J. Morel.—This paper does not admit of useful abstraction.

Reaction of Barium Sulphate and Sodium Carbonate under the Influence of Pressure.—W. Spring.—The author made an intimate mixture of pure barium sulphate and sodium carbonate, in the proportion of 1 part of the former to 3 parts of the latter. Portions of this were submitted to the action of pressure alone, of pressure and time, and of pressure and temperature. By a pressure of 6000 atmospheres, applied for a few moments only, 0.94 per cent of the total quantity of barium sulphate was converted into barium carbonate. As regards the action of pressure and time, if the cylinders obtained by 1, 3, or 6 successive compressions were left to themselves for a longer or shorter time, the chemical action did not cease with the pressure, but went on for some days after. Thus after 6 successive compressions, each of 6000 atmospheres, the quantity of barium sulphate transformed was on the sixth day afterwards 8.99 per cent, and on the twenty-eighth day 11.08 per cent. It is difficult to interpret these facts without ascribing to matter the property of interdiffusion, even in the solid state. No similar change took place in a portion of the mixture which had not been submitted to pressure. In order to determine the action of pressure with heat, two cylinders, obtained by 3 and 6 successive compressions respectively, were cut into two equal parts. Two of these halves were analysed after fourteen days without having been heated, and yielded respectively 9.01 and 10.89 per cent of transformed barium sulphate. The other two were heated to 120°, in a dry stove, for three hours, and on analysis they showed, contrary to expectation, less transformed barium sulphate than the two halves which had not been heated, the results being respectively only 7.07 and 9.01 per cent. Hence the action of heat seems contrary to that of pressure.

Absorption of Nitrogen Dioxide by Ferrous Salts.—Jules Gay.—The author concludes that the absorption of this gas by ferrous salts is a definite combination and not a solution.

Action of Heat upon Benzyl-mesitylene.—E. Louise.—The author has obtained products which he names dimethyl-anthracene α , dimethyl-anthraquinone α , dimethyl-anthracene β , and dimethyl-anthraquinone β , all which he describes here at length.

New Method for Assaying Tanniferous Matters.—Ferdinand Jean.—This paper will be inserted in full.

Experiments on Fatty Matters.—Ch. Dubois and L. Padé.—This paper requires the accompanying diagram.

Action of Certain Potassium and Sodium Salts upon the Corresponding Salts of Tetra-methyl-ammonium.—A. Müller.—The author's experiments show that the bases studied, compared among themselves, may be arranged in the order of their decreasing power as KHO, NaHO, and N(CH₃)₄HO.

Synthesis of an Acetone by means of an Acetylenic Carbide.—A. Béhal.—Not suitable for useful abstraction.

Nos. 6 and 7, October 5.

This double issue contains no original papers.

Moniteur Scientifique, Quesneville.
Vol. xv., November, 1885.

Address to the Chemical Section of the British Association.—Prof. H. E. Armstrong.

On Chemical Action.—Prof. H. E. Armstrong.

The Preservation of Timber.—S. B. Boulton.—A paper read before the Society of Civil Engineers, London.

Origin of the Process of Manufacturing Soda by means of Ammonia.—L. Mond.

On Algine.—Report by Watson Smith.—The foregoing memoirs are all translated from English sources.

Review of Researches on Alkaloids.—This review contains notices of an iodised quinoline, of the oxidation and reduction products of collidine aldehyd, on a new methyl-piperidine or β -picoline hexahydride, on the preparation of α -lutidine, on papaverine, and on narceine.

Dr. Ferran's "Cholera Vaccine."—Drs. Chantemesse and Rummo.

Industrial Society of Mulhouse.—Sessions of July 8, Sept. 9, and Oct. 14.—M. Weber read a paper on rose-coloured stains in pieces printed with aniline black. Pieces which have been printed with lime and rosin soap under pressure are never thus coloured, whilst those which have been similarly treated in open vessels always take this tint more or less. M. Camille Kœchlin and M. Binder have been examining the action of manganese bronze upon aromatic bases and have obtained a variety of products. The oxidation of benzidine in this manner gives a brown finer than the original manganese brown and remarkably fast.

Revivification of Baryta.—MM. Leplay and Radot.—The authors propose to revivify barium carbonate by the action of coal-gas.

The Action of Papaine.—S. H. C. Martin.—Translated from an English source.

Detection of Adulteration in Oils.—O. C. S. Carter.—From the *American Chemical Journal*.

Review of Analytical Chemistry.—A series of extracts from the *Zeitschrift f. Analyt. Chemie* and the *Berichte der Deutschen Chem. Gesell.*

Patents relating to the Chemical Arts.—French chemical patents issued in September.

NOTES AND QUERIES.

* * Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Saffron Surrogate.—Can any of your readers say of what saffron surrogate is composed?—READER.

Charcoal Pastilles.—Can any reader inform me what chemical solution I can soak charcoal in, so that when it is dry, and a light is applied to it, the charcoal will ignite and burn until consumed?—F. W.

Soluble Oil.—Will some reader kindly inform me how this is prepared on a large scale, and also how the *special* soluble oil is prepared which is used in "finishing" along with Epsom salts and china clay, or the name of any book which treats on the manufacture of this article?—A SUBSCRIBER.

Detection of Butyric Acid in Glycerol.—(Reply to "A.")—Heat with alcohol + H_2SO_4 , examine for odour of ethyl-butyrate. If a fruity smell only be perceived differentiate between formic and butyric acids by adding ammonio-silver nitrate to original substance diluted with water. A black precipitate is produced on standing if formic acid be present. Neutral $AgNO_3$ will give a dark precipitate on boiling if butyric acid or acrolein be present.—A. PERCY SMITH.

MEETINGS FOR THE WEEK.

MONDAY, 30th.—Medical, 8.30.

— London Institution, 5.

— Society of Arts, 8. (Cantor Lectures,) "The Microscope," by John Mayall, Jun.

TUESDAY, Dec. 1st.—Institution of Civil Engineers, 8.

— Pathological, 8.30.

WEDNESDAY, 2nd.—Society of Arts, 8. "Technical Art Teaching," by F. Edward Hulme, F.L.S., F.S.A.

— Geological, 8.

— Obstetrical, 8.

THURSDAY, 3rd.—Chemical Society, 8. (1.) "The Sugars of the Cereals and in Malted Grain." (2.) "On the Presence of Raffinose in Barley," by O. O'Sullivan, F.R.S. "On the Evidence of Constitution afforded by Absorption Spectra," by Captain Abney, F.R.S.

FRIDAY, 4th.—Geologists' Association.

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THE CHEMICAL NEWS.

VOL. LII. No. 1358.

ON THE MICRO-ORGANISMS OF POTABLE WATERS: THEIR LIFE IN CARBONIC WATERS.

By Dr. T. LEONE.

THE analysis of potable waters, until the most recent times, has been in the exclusive competence of chemists. The existence of minute, microscopic, living organisms in potable waters has been known, but the want of suitable methods has always compelled analysts either not to occupy themselves with this question at all, or to do it in a perfunctory manner, including these beings in the determination of the organic matter.

But the existence in Nature of pathogenic organisms being recognised and confirmed has already passed into the domain of Science, and the probability that some of these may be found in waters enables us to foresee what a part of its territory chemistry must, in these researches, yield up to bacteriology, as soon as this new science shall have reached its full development.

And in fact it is beyond doubt that by the ingenious methods of culture of Robert Koch we have found a good method for such investigations, by which it is sought to complement the chemical analysis of water by its bacteriological examination.

Many experimentalists who have occupied themselves with the study of microbia on Koch's method have contented themselves with the summary appreciation of the value of a potable water according to the number of microbia present, capable of producing "colonies" in gelatin. It is believed that the bacteria derived from putrescent animal matter produce colonies which liquefy gelatin. From the number of such colonies it is believed that we may form an opinion as to the greater or less corruption of a water.

But the greater part of such experimentalists think that in these researches we have not been guided by an exact conception of the nature of these microbia. Indeed, since the majority of such experimentalists have not taken account in such researches of the time which has elapsed from the moment in which the water was obtained to that when it was experimented upon, and since these experimentalists have ascribed to a water thousands and thousands of microbia per c.c.,—a water which may have required two or three days' journey from its source to the point where it comes to be examined,—it is to be supposed that these experimentalists have disregarded the possibility that the purest drinking-water may be a good medium for the culture of microbia. What value is to be conceded to these researches will be seen from what will be explained below.

My researches have all been conducted by the gelatin method. The gelatin employed for each cultivation was 10 c.c.

The proportions of the substances used in preparing this gelatin were:—

Water	..	..	..	..	100.0 parts.
Gelatin	..	..	..	..	10.0 "
Peptone	..	..	..	..	0.5 "
Extract of meat	..	..	..	..	0.5 "
Sodium phosphate	..	..	..	..	0.5 "
Sodium carbonate enough to produce a faint alkaline reaction.					

The cultivations were made upon plates of glass, on each of which the gelatin occupied a surface of 0.08 square

metre. The water under examination was used in proportions of 0.1 to 0.5 c.c. If the quantity of microbia was so great as to interfere with their exact enumeration it was diluted with distilled and sterilised water. The quantity used in each mixture was from 0.1 to 0.5 c.c. It was measured by means of a pipette of small calibre, graduated in tenths of a c.c. The preparation of such cultures was effected at temperatures below 30°. The gelatin, the pipette, the glass plates, the tubes,—everything, in short, which came in contact with the cultures, or might have any connection with them, was duly sterilised, either by heat or by a solution of sublimate.

For the enumeration of the colonies, the culture, placed on a black ground, was covered with a plate of glass divided into square centimetres, and the colonies were enumerated with the aid of the microscope.

An appreciation of potable waters according to the criteria previously put forward, depending on the number of the colonies in general, or in particular on the number of those which liquefy gelatin, it was my first intention to examine if a potable water, although the purest, was such a nutrient medium for microbia as to render variable, and consequently erroneous, such an appreciation if the research is not immediately executed.

To this end waters from different sources were examined, the results leading all to the same conclusion. I give those only yielded by the water-supply recently introduced into the city of Munich from the Maugfall.

This water may be taken as a type of the purest potable waters. It contains not a trace of nitrates, nitrites, or ammoniacal salts; it leaves a residue of 284 m.grms., and the organic matter contained in a litre of the water may be oxidised by only 0.99 m.grm. of oxygen.

This water was brought to a cock connected with a main in which the water, coming directly from the great reservoir, was flowing continually. The cock was sterilised by the heat of a Bunsen lamp.

The recipient vessels were always washed with strong sulphuric acid, then with distilled water, and were then sterilised by being heated for an hour to 150°.

These recipients, filled to two-thirds and closed with plugs of cotton-wool, likewise sterilised, were left at rest in an atmosphere where the temperature ranged from 14° to 18°.

For brevity's sake I omit the details of the researches, and pass directly to an exposition of the results, confining myself to say that the figure given must be considered as the mean of the values furnished by such cultures.

The following are the results:—

The Maugfall water arrives at Munich with five microbia per c.c.

After twenty-four hours, being left under the conditions above described, the number of microbia is found to have risen to more than a hundred per c.c. In two days the figure reaches 10,500. In three days, 67,000. In four days, 315,000. And on the fifth day there were more than half a million of microbia per c.c.

So rapid and considerable an increase of microbia in waters I find noticed only in a very recent publication by Dr. Cramer, Professor in the University of Zurich. Prof. Cramer, in his Memoir on the Waters of the City of Zurich, proves that the microbia in such waters increase rapidly on standing.

But it must be observed that the action of repose has no influence on the increase of the microbia.

The experiments which follow prove that the microbia in potable waters in movement multiply with the same rapidity, and in the same proportion, as if the said waters were at rest.

For these experiments were used glass tubes of the length of 60 centimetres and the diameter of 4 centimetres. They were washed with strong sulphuric acid, then with distilled water, and were then sterilised for an hour at 100° (in an atmosphere of steam).

These tubes were sealed at the lamp, after being half-filled with the above-mentioned Maugfall water, and were

then arranged perpendicularly to the axle of a wheel, so that the angle was intersected by the middle part of the tubes.

The wheel was set in continuous motion by a current of water, and the apparatus was so arranged that the entire water in the tubes was not at rest for an instant.

The experiment being thus arranged I made, from time to time, examinations of the quantity of microbia contained in the water. I shall spare the description of the detailed results of these researches, which do not need to be repeated. Approximately the same figures were found that were obtained above. The variation of the number of micro-organisms in the water in motion follows the same course as that of the same water when at rest. In both cases the number of the microbia reached on the fifth day the same maximum, and then decreased. On continuing the research I found that on the tenth day the number of the microbia had fallen to 300,000, in a month to 120,000, and finally, in six months, the water contained only 95 microbia per c.c.

To appreciate, therefore, according to this method the pollution, and in general the degree of corruption of a water, the examination ought to be begun immediately on taking the sample. In such an appreciation we ought also to take account of the increase of microbia during the flow of the waters, to the end that an extraordinary number of microbia may be attributed either to a natural increase or to an incidental pollution.

With respect to the five microbia per c.c. contained in the Maugfall water at the moment of its arrival in Munich (which from its source to its arrival at Munich takes about twenty-four hours) it has been observed that in this case the figure is not augmented during the course of the water. It has been observed in fact that the Maugfall water arrives at Munich under a pressure of 5 to 6 atmospheres. It is thence admitted, with much probability that the vitality of the microbia is abated under this pressure. Dr. Karl Lehmann has experimentally demonstrated that such an influence is exerted upon many of the lower organisms by a strong pressure of oxygen. Prof. Maggi, of the University of Pavia, has found that the water of Lake Maggiore at depths exceeding 60 metres no longer contains bacteria.

As a rapid alteration of the hygienic conditions of a water results from the rapid increase of microbia it seemed to me of not trifling interest to examine the behaviour of carbonic waters which are ordinarily drunk in a period more or less long from their preparation.

For these researches there were prepared ordinary bottles of carbonic water (water saturated with carbonic acid under pressure), and at the same time there were taken as a check samples of the potable water which served for their preparation.

Care was taken to use sterilised bottles and stoppers. As for the apparatus for the carbonic water the water-receiver was always kept filled during the preparation of our samples. Portions both of the carbonic water and of that unprepared were submitted to cultivation, to fix the initial conditions of the experiment.

From these cultivations it resulted that: the carbonic water contained 186 microbia per c.c., and the original water only 115.

Upon each of the two waters were made comparative examinations at intervals of five days for a period of fifteen days.

In these researches it was found that whilst in the non-carbonic water the number of microbia rose in five, ten, and fifteen days from hundreds to thousands per c.c., in the carbonic water the number of microbia not only did not increase but it diminished. In five days the number of organisms had fallen from 186 per c.c. to 87; in ten days to 30; and in fifteen days to 20.

This absence of increase in the carbonic waters may be due to one of the following causes:—(1) Action of carbonic acid; (2) action of pressure; (3) joint action of carbonic acid and pressure; (4) deficiency of oxygen. We

may set pressure aside. I admit, indeed, that it may be sufficient to hinder the development of microbia, but in our case it is not necessary. In examining three qualities of carbonic mineral waters, *Giessel*, *Selters*, and *Apollinaris*, which were under very slight pressures, I have always found a scattered quantity of organisms which went on decreasing. But the decisive proof for excluding the necessity of pressure is in the researches made on carbonated water prepared at an ordinary pressure.

Into Maugfall water contained in sterilised bottles I caused to bubble for half an hour, with occasional stirring, a current of carbonic acid developed by the action of hydrochloric acid upon calcium carbonate.

The carbonic acid before passing into the water under examination was made to pass into two bottles containing solutions of sodium carbonate, to remove the traces of hydrochloric acid which may have been mechanically carried along by the current.

The carbonic water being thus prepared the bottles were closed with ground glass stoppers secured with a layer of paraffin.

The water being left in this condition, it resulted from researches made in the period of 15 days that in this case also the quantity of microbia did not increase, but diminished.

Pressure being thus excluded there remained only as the cause hindering the increase of the microbia either the action of the carbonic acid or the want of oxygen.

But it has been possible, also, to exclude oxygen. Into the same Maugfall water contained in sterilised bottles there was passed for an hour a current of hydrogen, taking care to stir. The hydrogen, generated by the action of dilute sulphuric acid upon zinc, was washed by a passage through a solution of caustic potash. The bottles thus prepared were hermetically closed, and the water examined from day to day.

But the organisms in this water, which as regards oxygen would be in the same condition as the carbonic water prepared at the ordinary pressure, increased rapidly and similarly to the microbia in water which was in free contact with the atmosphere.

These results place it beyond doubt that atmospheric oxygen is not an element necessary for the increase of microbia in potable waters, and that the carbonic acid is the sole agent which interferes with the life of these organisms in carbonic waters.

These researches have been made in the Hygienic Institute of the University of Munich. The author feels it both a duty and a pleasure to return thanks publicly to the illustrious sanitarian, Prof. Max Pettenkofer, who during his stay in Germany, has given him the use of his laboratory and assisted him with suggestions.—*Gazzetta Chimica Italiana*, vol. xv., p. 385.

SPECTRUM OF AMMONIA BY REVERSION OF THE INDUCTION SPARK.

By M. LECOQ DE BOISBAUDRAN.

WHEN we let the induction spark play on an aqueous solution of ammonia, making the liquid positive, a yellow globulous or "cupuliforme" envelope is formed in the interpolar space, it becomes narrower towards the bottom, while its brilliancy increases and terminates in a point very near the liquid. Around this point and very close to the upper surface of the liquid a very thin greenish disc appears, sharply defined. The light of this disc gives a beautiful green band in the spectroscope.

The yellow envelope also gives a spectrum (of a very different order to that of the green disc) which appears to be identical with one of those described by Dibbits and

A. Mitscherlich,* and obtained by means of a flame charged with ammonia. This spectrum is composed of a good number of nebulous lines, of which some very near to each other coalesce, forming small nebulous bands. The principal lines or bands only are described here.

Spectrum of the Yellow Interpolar Envelope.†		
	Micrometer.	λ.
γ	88.9	632.5 Nebulous line, but not wide.
	89.6	629.3 As above, but well marked; stronger than 88.9; attached in the preceding one, with which it forms a small nebulous band when the slit is opened wider.
η	92.3	618.0 Nebulous line, but not large, a little feebler than 89.6.
β	95.6	604.5 Little smaller, but nebulous; very well marked.
	96.6	600.8 Very cloudy and thick line; strong, but decidedly less so than 95.6, which it joins.
ζ	97.9	596.4 Very cloudy line, a little weaker than 96.6.
α	105.8	570.2 Little smaller line, but cloudy, pretty strong.
	Nearly 113.8	547.0 Very indefinite commencement of a band a little lower towards the left, easily visible because of its width; appears to be formed of several nebulous lines.
δ	About 115.0	Middle of the band.
	About 116.2	540.6 End cloudy, but less vague than the beginning.
ε	122.5	525.2 Apparent middle of a very small band about one division of the micrometer in width; a little fainter than δ 115.0.

Spectrum of the Small Disc near the Liquid.		
	Micrometer.	λ.
	About 105.7	Cloudy commencement of the band.
	106.5	568.1 Middle of the greatest light of a cloudy line about $\frac{1}{4}$ to $\frac{2}{3}$ of a division, joined to the following one by a nebulous light; very well marked.
	107.8	564.3 Middle of the maximum light of a very cloudy line $\frac{3}{4}$ to $\frac{1}{10}$ of a division wide, more cloudy than 106.5, but a little brighter.
	About 108.9	End of the band more cloudy than the commencement.

Note.—This spectrum is seen as above with a moderate size slit; when it is larger the lines 106.5 and 107.8 become confused and form a tolerably bright band, having its left edge a little sharper than its right, and its middle at about 107.3 or 107.4.

The band 107.3 corresponds very well to one of three bands shown in one of the drawings by Mitscherlich; its formation is not due to an effect of phosphorescence,

properly speaking, but to the illumination of the ammoniacal vapour traversed by the positive portion of the discharge which spreads itself over the liquid. With air and a neutral solution we obtain a similar disc, giving the primary spectrum of nitrogen.

The same spectrum of the green band 107.3 takes place when we pass an induction spark between two platinum wires in vapour of ammonia; the spark is yellow, but differs spectrally from that obtained in air over an aqueous solution of ammonia in this respect, that this latter does not give the band 107.3, and shows rather strongly the other lines described above.

With the moist gas given off by boiling the ammoniacal solution the band 107.3 is stronger as we examine a point nearer the positive pole, and the other lines are well marked, especially at a certain distance from the positive platinum.

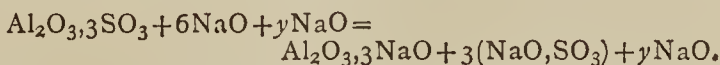
In nearly pure and dry vapour of ammonia the band 107.3 becomes stronger as it approaches the positive pole, but the lines of the other spectrum are quite extinct, except the band β 95.6 to 96.6, of which I have always found a feeble trace. If we let several bubbles of dry air into the current of gaseous ammonia which passes between the platinum electrodes we immediately see a number of lines appear. It is therefore the presence of oxygen which causes this spectrum.

The band 107.3 is not produced with solutions of ammoniacal salts exempt from free ammonia; aqueous solutions of trimethylamine and triethylamine do not give it. With these two last compounds a bluish disc is formed on the liquid whose spectrum is that of carbon (the blue flame of coal-gas).—*Comptes Rendus*, July 6, 1885.

A VOLUMETRIC METHOD FOR THE DETERMINATION OF ALUMINA.

By Dr. K. J. BAYER.

THIS method depends on the following principles:—If we take a given quantity of a solution of alum, and add normal soda until the precipitate formed is completely re-dissolved, we obtain an alkaline solution of alumina along with sodium and potassium sulphates. If this solution is mixed with tincture of litmus and accurately titrated with normal sulphuric acid to incipient reddening (which with care may be effected with great precision, in spite of the liberation of ammonia), a number of c.c. of normal sulphuric acid are required much smaller than the quantity of normal soda just employed, according to the following equation:—



Titration indicates here merely the 3NaO in combination with the alumina, and the excess added $y\text{NaO}$.

The difference between the normal sulphuric acid used in titration and the normal soda originally added, gives the quantity of normal soda representing the quantity of sulphuric acid required for the complete neutralisation of the alumina present.

If, on the other hand, we add tropeoline as an indicator to a solution of alum mixed with a given excess of normal soda, and then add normal acid until the alumina liberated at first is re-dissolved (*i.e.*, until the pure lemon-yellow of the tropeoline begins to pass into orange), a number of c.c. of normal acid are consumed exactly representing the normal soda originally employed.

From these facts the determination of the alumina follows naturally. In order to test the accuracy of the method, the author dissolved 5.7214 grms. alum in 250 c.c. water. Of this solution 100 c.c. were supersaturated with soda up to complete solution, and were again made up to 250 c.c. Of this alkaline solution 100 c.c. were titrated

* *Philosophical Magazine*, vol. xxviii., p. 169.

† The actual measurements are not absolute, but their errors can only be very small; the relative intensities of the lines are as seen with a pretty large slit.

with litmus as indicator, and another 100 c.c. with tropeoline as indicator. The difference of both was 5.55 c.c. of normal sulphuric acid, representing 0.09507 grm. Al_2O_3 , or 10.39 per cent of alumina in the alum employed.

In all analogous cases, *i.e.*, in case of acid solutions of alumina, a known quantity of such solution is supersaturated with soda-lye, made up to a given volume, and then titrated on the one hand with litmus, and on the other with tropeoline as indicator. The difference between both titrations shows the quantity of sulphuric acid representing the alumina.

The reaction with tropeoline can be best recognised by titrating in porcelain capsules. It is well not to have more than 40 to 50 c.c. of liquid, mixed with $\frac{1}{2}$ c.c. of a weak solution of tropeoline in water (1 : 1000). Inexperienced persons may, for comparison, colour 40 to 50 c.c. of water in another capsule with $\frac{1}{2}$ c.c. of the above tropeoline solution, and judge accordingly.

In this titration it is requisite to add ultimately an excess of normal sulphuric acid, which is then titrated back with normal soda. The application of heat must be as far as possible avoided.

Solutions containing lead, cadmium, zinc, tin, antimony, and other heavy metals whose oxides are soluble in soda, must first be freed from these bodies before determining the alumina. If other bases are liberated on adding soda it is well to filter and to wash the precipitate before making up the liquid to a known volume and titrating.

As aluminium phosphate is readily soluble in soda it may be possible to determine the alumina here without a previous separation of the acid. But this point has not yet been experimentally decided.

If alkaline solutions of alumina are to be examined the procedure is the same. Silica, if present, does not affect the result.—*Zeitschrift für Analytische Chemie*.

NEW RESEARCHES ON THE COMPOUNDS OF DIDYMIUM.*

By P. T. CLEVE.

(Continued from p. 265)

Carbonate of Didymium and Potassium, $\text{DiK}_2\text{CO}_3 + 6\text{H}_2\text{O}$.

ON mixing a solution of acetate of didymium with an excess of bicarbonate of potassium a gelatinous and bulky precipitate was thrown down. It was left in the liquid for some time, and had then changed into brilliant lilac-coloured needles. The salt was pressed between filter-paper and subjected to the following analyses:—

0.7721 grm. lost by 110° 0.2018 grm. H_2O .

0.8372 grm. gave 0.3376 grm. Di_2O_3 and 0.1597 grm. KCl .

0.8632 grm. gave 0.3457 grm. Di_2O_3 and 0.1653 grm. KCl .

In per cent—

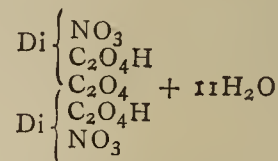
				Calculated.	
Di_2O_3	..	—	40.32	40.05	166.0
K_2O	..	—	12.04	12.09	47.1
CO_2	..	—	—	—	88.0
H_2O	..	26.14	—	—	108.0
					409.1

The composition agrees perfectly with that of the corresponding salt of samarium. In my paper on didymium of 1874† I arrived on calculation at the same formula, but with only $2\text{H}_2\text{O}$. The salt then analysed was dried over oil of vitriol and had lost $4\text{H}_2\text{O}$.

* Presented to the Royal Society of Sciences of Upsala, March 20, 1885.

† *Bihang till K. Sv. Vet. Akad. Handlingar*, ii., No. 8, p. 20.

Nitro-oxalate of Didymium,



A solution of oxalate of didymium in nitric acid deposits by slow evaporation over caustic potash at the ordinary temperature beautiful brilliant and transparent red crystals, sometimes of considerable size (2—3 centimetres). The salt is unstable and emits in the air nitric acid. It is also decomposed by pure water.

- I. a. 0.7856 grm. left on ignition 0.3075 grm. Di_2O_3 .
 b. 0.4950 grm. was decomposed with ferrous chloride and hydrochloric acid, and gave 25.2 c.c. NO of the $t^\circ 17^\circ.5$ and under the barometric pressure of 750 m.m.
 c. 0.6563 grm. was burnt with oxide of copper and the nitrogen determined as usual by the Dumas method. 17.6 c.c. nitrogen, $t^\circ 17^\circ$, barometric pressure 750 m.m., were thus obtained.
 d. 1.0215 grm. was burnt with chromate of lead, and gave 0.2519 grm. H_2O and 0.3169 grm. CO_2 .

- II. a. 0.5714 grm. gave by ignition 0.2225 grm. Di_2O_3 .
 b. 0.7013 grm. gave by the same method as I. b 37.1 c.c. NO, $t^\circ 18^\circ$, pressure 762 m.m.

In per cent—

		I.	II.	Calculated.	
Di_2O_3	..	39.14	38.94	332	38.07
C_2O_3	..	25.38	—	216	24.77
N_2O_5	..	11.16—11.82	11.77	108	12.39
H_2O	..	24.66	—	216	24.77
				872	100.00

There is some doubt as to the number of mols. of H_2O which the salt contains, as I have found too much Di_2O_3 and too little N_2O_5 , but it seems to me most probable that the formula given above is the right one.

Specific gravity—

0.6429 grm., small crystals, $t^\circ 13.2^\circ$, sp. gr. 2.424

0.6587 " " " " 2.425

Molecular volume, 359.7.

Vanadates of Didymium.

1. *Orthovanadate*. DiVO_4 . If neutral solutions of metavanadate of ammonium and nitrate of didymium be mixed, a greyish, finely divided precipitate is thrown down, which on washing easily passes through the filter. The precipitate was mixed with an excess of chloride of sodium and heated to bright redness. After cooling and dissolving out the chloride of sodium an amorphous greyish powder was obtained.

0.8095 grm. was dissolved in hydrochloric acid, sulphurous acid was added to reduce the vanadic acid, and then oxalic acid. The precipitated oxalate of didymium left on ignition 0.5166 grm. Di_2O_3 . The filtrate from the oxalate was evaporated to dryness and heated to destroy the oxalic acid. Nitric acid was then added and the whole evaporated. On igniting this residue 0.2910 grm. V_2O_5 was obtained. It contained 0.0084 grm. Di_2O_3 . The analysis had thus given 0.5250 grm. Di_2O_3 and 0.2826 grm. V_2O_5 .

In per cent—

			Calculated.	
Di_2O_3	..	..	64.85	332
V_2O_5	..	..	34.91	182
			99.76	514
				100.00

Specific gravity—

1.7336 grm., t° 21.2°, sp. gr. 4.963

0.7765 " " " 4.959

Mean of both determinations, 4.961.

Molecular volume, 51.8.

2. *Acid salt.* $\text{Di}_2\text{O}_3 \cdot 5\text{V}_2\text{O}_5 + 28\text{H}_2\text{O}$. A solution of bivanadate of sodium gives with nitrate of didymium an amorphous yellow precipitate, probably of the above salt, and the filtered solution deposits soon brilliant red crystals.

0.5458 grm. lost at 100° 0.1332 grm. H_2O , or 24.40 per cent.

0.6980 grm. lost at about 350° 0.1982 grm. water, and gave, by the same method as adopted in analysing the above salt, 0.1339 grm. Di_2O_3 and 0.3595 V_2O_5 .

In per cent—

		Calculated.		
Di_2O_3	.. ..	19.18	332	19.01
V_2O_5	.. ..	51.50	910	52.12
H_2O}	.. ..	28.39	504	28.87
		99.07	1746	100.00

The loss at 100° corresponds with 24 mol. H_2O , calc. 24.74.

Specific gravity—

1.150 grm., t° 18.5° sp. gr. 2.492

0.4294 " " " 2.497

Mean of both determinations, 2.494.

Molecular volume, 350.

Crystalline form monosymmetric:

$$a : b : c = 1.61389 : 1 : 1.63433.$$

$$\beta = 81^\circ 18'.$$

Planes: ∞P ; oP ; $\infty P\infty$; $+P\infty$; $-P\infty$; $+P$.

(C. Morton).

Formiate of Didymium, Di_3CHO_2 .

This compound was obtained by boiling the oxide of didymium with dilute formic acid. The salt is a light violet powder, composed of microscopic needles. Heated it leaves the oxide in finely divided state.

0.4982 grm., dried at 100°, gave by evaporation with sulphuric acid 0.5119 grm. Di_2SO_4 .

In per cent—

		Calculated.		
Di_2O_3	.. ..	59.64	166	59.93
$\text{C}_2\text{H}_2\text{O}_3$	.. ..	(40.36)	111	40.07
		100.00	277	100.00

Specific gravity—

0.4616 grm., t° 20°, sp. gr. 3.433.

0.8500 " " " 3.427.

Mean of both determinations, 3.430.

Molecular volume, 80.8.

(To be continued).

Spectroscope for Blast-Furnaces and for the Bessemer Process.—Ch. V. Zenger.—The author's apparatus, described in a foregoing paper not susceptible of abridgment, may serve for the study of the dazzling flames of the Bessemer converter and for the analysis of the gases given off. By turning the back to the converter we secure this advantage, that the eye is not affected by the radiation of the flame. By placing near the mirror at the visual distance a micrometer on a slender plate of gypsum or mica we may easily measure with a sufficient precision the distance of the most important luminous rays, taking as a mark the division corresponding to the double sodium line DD.—*Comptes Rendus*.

A MODIFICATION OF THE MOLYBDATE METHOD OF ESTIMATING PHOSPHORUS IN STEEL.

By E. FRED. WOOD, M.E.

HAVING long felt the need of a rapid method for estimating phosphorus in steel, which should be at the same time simple and accurate, a series of experiments was made which resulted in the adoption of the following "Chromic Acid" process, of which four months' practical working has proved the accuracy and value.

It is well known that all the phosphorus cannot be precipitated from a nitric acid solution of steel by molybdic acid solution unless some process, as evaporation to dryness and ignition, be gone through with to destroy some interfering substance or condition.

A series of experiments was made on 30 samples of steel of varied composition (carbon, 0.5 to 1.10; silicon, 0.00 to 0.39; and phosphorus, 0.49 to 0.380) to determine the amount and regularity of the phosphorus precipitable by molybdic acid solution.

1 grm. of steel was dissolved in 30 c.c. of 1.20 nitric acid, boiled till the carbonaceous residue was completely dissolved, cooled, and the phosphorus precipitated and weighed in the usual manner.

It was found that practically two-thirds of the phosphorus was obtained. In 26 of the samples, with less than 0.160 phosphorus, the results obtained by multiplying the weights found by 1.5 agreed very closely with those by the regular process (the maximum difference being 0.004); but in the remaining 4 samples, with phosphorus 0.170 to 0.380, the differences were 0.015 to 0.020; showing that while approximate results could be obtained the method was not strictly accurate or reliable.

Further experiment led to the adoption of chromic acid dissolved in strong nitric acid as a reagent for destroying the interference. The process is as follows:—Place in a 200 c.c. beaker 1.63 grms. steel, add 30 c.c. nitric acid sp. gr. 1.20; when violent action has ceased boil till the carbonaceous residue is completely dissolved and solution is concentrated to about 15 c.c., add 15 to 18 c.c. of a solution of 50 grms. of chromic acid in 1 litre of nitric acid sp. gr. 1.42; boil down to 15 c.c., rinse into an Erlenmeyer beaker flask, using as little water as possible, not to exceed 8 c.c.; cool to 40° C. or less, add 70 to 80 c.c. of molybdic acid solution warmed to 30° or 40° C.; shake violently for several minutes, then set aside for ten or 15 minutes.

The precipitation will then be complete, and the precipitate settled.

Prepare a filter 6 c.m. in diameter, of No. 1 Swedish filter-paper, dry it thirty minutes in a steam drying-bath at 100° C.; weigh rapidly to within 1 m.grm.

Remove most of the supernatant liquor with a syphon, and gather the yellow precipitate on the filter, using wash-water containing 2 per cent of 1.20 nitric acid, wash four to six times with this; dry, filter, and precipitate at 100° C. for forty to fifty minutes; weigh rapidly.

The phospho-molybdate of ammonia contains 1.63 per cent of phosphorus, so that each m.grm. of the precipitate is equivalent to 0.001 per cent of phosphorus in the steel.

To prepare the molybdic acid solution, place in a beaker 1200 c.c. of water, stir in 1 lb. of molybdic acid, add 700 c.c. of ammonia sp. gr. 0.90, stir till dissolved, then add 400 c.c. of nitric acid sp. gr. 1.42, and cool the solution.

Place in another beaker 715 c.c. of water, add 615 c.c. of 1.42 nitric acid, and then 600 c.c. of the first solution, taking care that the solutions are so poured together as to mix well. Let stand twenty-four hours, then filter for use.

In a time test two determinations were completed in one hour and twenty-five minutes. This time could be somewhat shortened by drying the yellow precipitate at 110° C.

In the following analyses of 27 samples of steel it will be seen that neither carbon or silicon, in the quantities usually present in steel, interfere.

The results in the last column were obtained by the usual molybdate process, in which the nitric acid solution of the steel is evaporated to dryness, ignited, dissolved in hydrochloric acid, the hydrochloric acid replaced by nitric acid, &c.

No.	Kind of Steel.	Combined Carbon.	Silicon.	Phosphorus by	
				Chromic Acid.	Regular Molybdt.
1.	Bessemer billet..	0.06	0.004	0.098	0.098
2.	" " ..	0.08	—	0.052	0.054
3.	" " ..	0.10	—	0.139	0.142
4.	Clapp and Griffith steel	0.15	0.014	0.391	0.387
5.	Bessemer billet..	0.23	—	0.092	0.093
6.	" " ..	0.25	—	0.132	0.132
7.	" " ..	0.54	—	0.128	0.128
8.	Crucible steel shaft	0.55	0.270	0.049	0.050
9.	Crucible cool steel	0.88	0.138	0.017	0.017
10.	Blown metal Bessemer	0.05	—	0.110	0.109
11.	Old rail, German.	0.16	0.390	0.127	0.134
12.	" ..	0.26	—	0.267	0.265
13.	Bessemer billet..	0.09	—	0.102	0.106
14.	Old rail	0.24	—	0.204	0.207
15.	Bessemer billet..	0.55	0.088	0.113	0.116
16.	" " ..	0.28	0.046	0.086	0.088
17.	Old rail	0.38	—	0.075	0.072
18.	Steel bar	0.28	—	0.097	0.097
19.	Partly blown metal, Bessemer.. ..	1.10	0.330	0.108	0.112
20.	Bessemer billet..	0.07	—	0.100	0.100
21.	Old rail, French..	0.60	—	0.174	0.179
22.	Bessemer billet..	0.20	—	0.151	0.152
23.	Old rail	0.34	—	0.072	0.072
24.	Bessemer billet..	0.08	—	0.102	0.098
25.	Steel axle	0.10	—	0.071	0.068
26.	Old rail	0.22	—	0.200	0.192
27.	" " ..	0.30	—	0.191	0.187

Experiments show that chromic acid dissolved in water or dilute nitric acid gives unreliable results, and cannot be safely used.

This prevents the application of the process to the analysis of pig-iron, as the strong nitric acid precipitates the silica in a form difficult to filter or to free from phosphorus; but it is hoped by further experiment to overcome this difficulty and make the process more generally applicable.

Pittsburgh, Pa., Oct. 29, 1885.

ESTIMATION OF WATER IN GLUCOSES, HONEYS, &c.

By H. W. WILEY and F. V. BROADBENT.

THE methods generally employed for the estimation of water in viscous liquids are so well known that it will not be necessary to describe them. Evaporation in flat dishes, with or without stirring, and drying with gypsum or sand, are the processes most frequently employed.

Anyone who has practised these methods need not be told how troublesome and unsatisfactory the results are. Variations in the percentages of moisture obtained are always expected and are frequently of considerable magnitude.

In the following experiments we have tried to develop a method which will give concordant and, therefore, comparable results.

The success of the experiments was largely due to the

even system of evaporation afforded by the steam drying oven described below.

This box contained three horizontal layers 1½ inch copper tubing placed at a vertical distance of 20 c.m. between them. This system of steam pipes was enclosed in a box made of soapstone. Any non-conducting material may be used for this box. Each layer of pipes is connected with the steam service and with a trap. By this arrangement all or any one of the sets of tubes can be furnished with steam. The steam is admitted by an automatic valve by which the pressure of the steam in the tubes of the box is constant, no matter what the pressure in the boiler may be. The top of the box is arranged like the roof of a house and carries a ventilating flue with a damper.

The box rests on leaden supports in a lead box over the bottom of which is placed a layer of pumice-stone saturated with sulphuric acid. All the air which enters the box must pass over this desiccating material. It therefore reaches the substances to be dried in the most favourable conditions. Each layer of tubes is provided with a thermometer. The trap is set so that no water will accumulate in the pipes and at the same time as little steam escape as possible.

Experience has shown that with 20 lbs. pressure of steam the middle system of tubes will give a constant temperature of 100°. The bottom and top floor are a little cooler.

With 40 lbs. pressure the central floor will show a temperature of 107°, when the damper is closed. The dishes containing the substances to be dried are carried in trays made of wire gauze. A box of the size described will hold more than a hundred 3-inch dishes.

Outline of Method.

About 2 grms. of the substance are taken, and dissolved in alcohol. The alcohol should be of about 80 per cent strength, so that about 5 c.c. of it will dissolve the samples taken. If the sample contains much dextrine a weaker alcohol may be used. The platinum dish and short glass stirring rod are weighed together. Fine sifted sand previously gently ignited, washed with distilled water, and dried at 100°, is now poured into the dish from a weighing tube. About 15 grms. are enough. The alcoholic solution of the sample is at once taken up by capillary attraction. The sample is then dried in the oven for half an hour to one hour. It is then removed, and when cooled to about 70° 5 c.c. absolute alcohol are added and thoroughly mixed with the contents of the dish by the stirring rod.

The sample is allowed to stand for a few minutes until the absolute alcohol has had opportunity to penetrate all parts of the saccharated sand. The dish is then warmed at 70° to 75° for a few moments until nearly all the alcohol is driven off. It is then placed in the oven and dried to constant weight.

Data of Work.

The first attempts at drying were made in an ordinary air bath, the final temperature being carried up to 110°. Owing to the great difficulty in securing an even temperature in such a bath the results obtained were very unsatisfactory.

The following per cents were some of the best of those obtained with a sorghum syrup:—

Weight Syrup.	Weight water driven off.	Per cent Water.
2.247	0.5777	25.71
2.724	0.6890	25.29
2.267	0.5828	25.71
2.688	0.6883	25.61
2.609	0.6681	25.61
2.174	0.5575	25.65

Other duplicate trials differed so widely as to cause the abandonment of the work at that temperature.

The next trials were made with a sample of separated honey.

The final drying (*i.e.*, after addition of the anhydrous alcohol) was continued for $1\frac{1}{2}$ hours, in the steam bath at 98.5° .

Weight Honey.	Water.	Per cent. Water.
2.1241	0.4339	20.43
2.2807	0.4604	20.19
1.7997	0.3662	20.35
2.0568	0.4189	20.37
2.1281	0.4339	20.39

To determine the proper length of time to secure the best results on final drying the following determinations were made.

The samples were taken from a can of glucose made from sorghum seed.

Time.	Per cent H ₂ O. 1st dish.	Per cent H ₂ O. 2nd dish.	Per cent H ₂ O. 3rd dish.	Per cent H ₂ O. 4th dish.	Per cent H ₂ O. 5th dish.
2½ hrs.	23.95	24.14	23.70	23.50	24.01
4 "	24.28	24.33	24.19	23.91	24.23
5 "	24.37	24.42	24.21	23.98	24.47
6½ "	24.54	24.58	24.47	24.29	24.50
7½ "	24.53	24.58	24.52	24.32	24.48

The temperature of the steam oven remained uniformly at 98.5° .

These results show that the final drying should be continued for six hours. Since an oven like the one used will hold a hundred dishes and has an automatic valve to maintain a constant pressure of steam, and therefore a constant temperature, the long drying is attended with no inconvenience.

We believe that the above procedure can be safely recommended as the best method of determining the free water in substances like those mentioned. It can also be employed for other bodies insoluble in alcohol but soluble in ether, &c., such as fats. In all cases, however, these determinations should be made in duplicate or triplicate. In a matter of such difficulty and often of such importance a single trial should not be regarded as final.

NOTICES OF BOOKS.

A Text-book of Tanning: A Treatise on the Conversion of Skins into Leather, both Practical and Theoretical.
By H. R. PROCTER, F.C.S., of Lowlights Tannery.
London: E. and F. N. Spon.

THIS work, as learn from the preface, is an expansion of an article on tanning which appeared in "Spon's Encyclopædia." We are sorry to find that the author apologises for certain imperfections on the ground of failing eyesight. Two of the chapters, III. and XXIV., devoted respectively to commercial tanning materials and to the statistics of the leather trade, are from the pen of Mr. C. G. Warnford Lock.

Mr. Procter first takes into consideration the anatomical structure of hide. For microscopical investigations he prefers Hartnack's eye-pieces and objectives. He reminds the reader, however, that these objectives are constructed to work with a shorter tube than that customary in English microscopes, and that they will not perform well if its length exceeds 6 inches. In the next chapter we find an account of the chemical character of hide,—a substance which can scarcely be said to have been obtained in a state of purity. After the general description of tanning materials to which we have already referred, we come to the chemistry of the tannins, a complicated group of bodies very imperfectly understood, but by no means absolutely identical.

After noticing Stenhouse's classification of the tannins into such as give a bluish black or a greenish black with ferric salts he recommends another arrangement. Some of the tannins yield pyrogallol, others catechol, and others, again, a mixture of both. The first class gives a bluish black with salts of iron, and include galls, sumac, divi-divi, myrobalans, and pomegranate rind; the second class, giving a greenish black, include hemlock-bark, mimosa, cutch, gambier, and quebracho. As instances of the third class we have oak-bark and valonias. The tannins of the first class yield gallic acid, whilst those of the second give rise to phlobaphenes.

In the fifth chapter we find rules for the selection of water for use in tanning. Here mud is mentioned as being distinctly unfavourable. We cannot agree with the statement—"On dyeing, at least as regards dye-woods, the influence of bicarbonates is distinctly favourable, and this is also stated to be true of woad, cochineal, and indigo-carmine." Bicarbonates of lime and magnesia are certainly beneficial when it is desired to obtain sad colours with the woods, but with cochineal we have never found them other than hurtful. Woad is no longer used as a source of colour, though it is added to the warm vat as a promoter of fermentation.

Chapter VI. discusses the analysis of water, the examination of commercial acids, of lime and lime-liquor, of sulphur in sodium sulphide, the determination of grease and soluble matters in leather, and of free acids in tannin-liquors. A more difficult matter is the qualitative detection of the various tannins. To this end the author gives in an elaborate table their reactions with dilute sulphuric acid, bromine water, dilute ferric chloride followed by ammonia, tartar emetic followed by ammonium chloride, copper sulphate followed by ammonia, lime-water, ammonium molybdate in nitric acid, sodium sulphide with exposure to air, lead nitrate, cobalt acetate, manganese acetate, uranium acetate, ammoniacal picric acid, and potassium dichromate. He admits, however, that further research is needed, since, *e.g.*, myrobalans cannot be certainly distinguished from divi-divi in presence of gambier.

As regards the quantitative determination of tannins, Mr. Procter, like most authorities, thinks none of the methods known perfectly satisfactory, but under most circumstances prefers the Löwenthal process. He admits that its results are merely relative, and give no information as to the absolute proportion of an unknown tannin.

The remaining chapters, dealing mainly with the manipulations and other procedures required for the different kinds of leather, are for us of little direct interest.

Of mineral-tanned leathers the author does not seem to form a very favourable opinion, though he writes:—"There seems no reason why good and durable leather for boot uppers and for many mechanical purposes should not be fabricated with salts of iron and chromium in conjunction with salt." Knapp's ferric sulphate process has been worked in Brunswick, but "apparently without financial success." The leather prepared by Heinzerling's chrome process, "in spite of the most determined and persevering efforts of the Eglinton Chemical Company, who own the British patent, has failed to take any prominent position in commerce." Mr. Procter considers, however, that this process has been modified for the better since. "Considerable improvements have been made in the finish and appearance of the goods. The leather in its present form possesses considerable resistance to water, is free from the brittleness so common in mineral tannages, and considerably exceeds bark-tanned leather both in toughness and in elasticity." So we may be permitted to doubt whether the slow progress made by this chrome-leather is due to any inferiority in itself, or rather to the prejudices which often set themselves in the way of any new departure.

We are glad to see that the author, whilst hoping that the work may be an assistance to teachers of the subject, as it undoubtedly will be—is "not intended as a cram-book."

for technical students." As a work of reference for the trade and for dealers in tanning wares it will be of great service.

Year-book of the Scientific and Learned Societies of Great Britain and Ireland. Comprising Lists of the Papers read during 1844 before Societies engaged in Fourteen Departments of Research, with the Names of the Authors. Compiled from Official Sources. Second Annual Issue. London: C. Griffin and Co.

WE have here a work which was much needed, and which, considering the great difficulties involved in its compilation, may be pronounced fairly accurate. The author will not, we trust, misapprehend our motives if we point out a few errors and oversights, and if we venture to throw out a few suggestions which may make future issues still more serviceable than the one before us.

Under the Royal Society of London we find no mention of its most important publication, well known as the *Philosophical Transactions*. The paper on the "Influence of Coal-dust in Colliery Explosions," mentioned in Part IV. of the *Proceedings* as by W. Galloway, should, if our memory does not deceive us, be ascribed to R. Galloway. In a variety of cases it seems to us that whilst the list of officers of the various societies and other details are those for 1885, the papers read are necessarily those for 1884.

The Institute of Chemistry seems not to have furnished any response to the author's circular requesting information. We find the statement that it was incorporated October 2nd, 1877. The fact is that it received its Charter only in the course of the present autumn, though it was registered under the "Companies' Act" on the date given.

Concerning the Society of Public Analysts, nothing is stated save the names and addresses of its President and Secretaries.

The Entomological Society has fared badly. It is said—doubtless by a clerical or typographical error—to have been founded in 1883, instead of 1833, and there is no mention of its incorporation by Royal Charter on July 20th of the present year. The fifth part of the *Transactions* for 1884 is not mentioned, and prices are stated at which the *Transactions* are supplied respectively to the public and to Fellows; but since the beginning of 1884 the Fellows receive the *Transactions* gratis.

We think, also, that exception might not unfairly be taken to the introduction in a work like the present of bodies which can scarcely be distinguished from political debating societies.

There are, further, not a few societies here mentioned—we refer especially to the photographic societies—which seem to be concerned rather with the fine arts than with science, and there are also certain bodies which are, in strictness, professional organisations, and which, however useful, cannot be said to be engaged in any department of research.

In any case we submit that the classification here adopted is capable of emendation. The arrangement followed is—(1) Science generally, *i.e.*, societies occupying themselves with several branches of science, or with science and literature jointly; (2) astronomy, mathematics, and physics; (3) chemistry and photography; (4) geography, geology, and mineralogy; (5) biology, including microscopy and anthropology; (6) economic science and statistics; (7) mechanical science and architecture; (8) naval and military science; (9) agriculture and horticulture; (10) law; (11) literature and history; (12) psychology; (13) archæology; and (14) medicine.

Now, with all deference to the author, we would propose a very different arrangement, to wit:—(1) Science generally; (2) mathematics, astronomy, mechanics; (3) physics, chemistry, and mineralogy; (4) geography, meteorology, and geology; (5) biology, including anthropology

and psychology; (7) sociology, including economics and statistics.

In a distinct division would follow literature, including law and history. A further section might comprehend such societies as concern themselves both with science and literature, and a last division would deal with the arts, photography, architecture, naval and military art, agriculture and horticulture, and medicine. As an appendix might follow societies which are in fact professional organisations.

It would greatly enhance the utility of this work if it gave certain particulars concerning each society, such as conditions of membership, entrance-fee, annual subscription, days of meeting, anniversary meeting, and election of officers.

We hope that the work will meet with a remunerative sale, so that the publishers may be induced to bring it out year by year.

CORRESPONDENCE.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—The letter signed "F.I.C." (*CHEMICAL NEWS*, vol. lii., p. 272) opens a question which is certainly of importance to most chemists.

The rumour to which "F.I.C." draws attention is, if correct, a distinctly retrograde step; and I would venture to suggest to the Council of the Institute that, if it has become necessary to recruit their ranks other than through the ordinary channel, the better way would be for them not to suspend their practical examinations, but rather to dispense—for a time—with the preliminary qualifications now required, substituting some more simple ones; say, having been engaged in practical work in any laboratory for two years, and having attended lectures on chemistry by a recognised Professor or Demonstrator of a College. This would, I think, work well in those cases where pupils in private laboratories, who cannot now present themselves for the examination of the Institute without previously undergoing a still further period of studentship at a college and passing some other examinations, might be able to take a course or so of lectures without throwing up or invalidating their articles, which they have (in most cases) had to pay a premium upon.

Then, when sufficient new and vigorous blood has been thus infused into the Institute, let them set to work to consider what can best be done for the benefit, first, of those who have kept on paying subscriptions, only receiving the vague honour of being able to add three comparatively unknown letters to their names; and secondly, for the body of chemists at large, who must inevitably be considered in any Act restricting the exercise of the profession.

The granting of a Charter is merely an official act of recognition of the body of men, as a whole, to whom it is granted, and so long as examination—or its equivalent—for ensuring the competency of each individual member of that body is not compulsory, it will carry little weight with the general public; therefore I for one consider that in abandoning their original intention of applying for an Act of Parliament, and in accepting a Charter of Incorporation instead, the Council of the Institute has actually blocked the way (for some considerable time at least) for the more important Act, which, if properly drawn and applied, might have been of value not only to chemists, but also indirectly to the public.—I am, &c.,

F.C.S.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—Referring to the letter from "F.I.C." (CHEMICAL NEWS, vol. lii., p. 272), I think it is a first-rate idea to admit Fellows on "*evidence of fitness*." "F.I.C." apparently ignores the fact that the majority of F.I.C.'s never passed the Institute's examination: they were admitted *en bloc*.

In the list of Fellows there are some I could name who are not "chemists" (Prof. or otherwise), who never have been, and I think never will be. I say—Admit to Fellowship on "*evidence of fitness*." I firmly believe it to be better than the Exam. system.—I am, &c.,

"A TEACHER."

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—From the letter of "F.I.C." (CHEMICAL NEWS, vol. lii., p. 272) it appears that it has been proposed to do away with the examinations of the Institute of Chemistry,—at least for a time,—and to admit to the Associateship and Fellowship "on such evidence of fitness as may be satisfactory to the Council." He does not seem very sanguine on the results; but I think he is wrong, for there are many, I am sure, like myself, who have been many years engaged in practical work, and have no doubt would be anxious to join the Institute, but really could not find time for any preparation for examination, and certainly could not come up to London for that purpose.

I should consider the acceptance of those who have been in private practice for a certain number of years, or held a post of trust, as Chief Analyst, &c., or, as "F.I.C." says, "on such evidence of fitness" as would be quite sufficient. Such evidence of fitness might certainly be decided by its being laid before the general body of Fellows and Associates.

Why not commence the Institute, now that it is to be placed on a legal footing, the same as others before it?—*i. e.*, as before stated, by admitting those who can prove their ability to be entitled to such honour.

It is to be hoped it may be made sufficiently public, so that all interested may know.—I am, &c.,

J.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—I am pleased to learn from the letter of "F.I.C." (CHEMICAL NEWS, vol. lii., p. 272) that "A report has been current during the last few days that a proposal has been made to the Council of the Institute of Chemistry to do away with the examinations of the Institute,—at least for a time,—and to admit to the Associateship and Fellowship 'on such evidence of fitness as may be satisfactory to the Council.'"

This is, I feel sure, a step in the right direction, and one to be commended. I would suggest the framing of a rule by the Council of such a nature as to enable any professional chemist who has been in active practice for a number of years (say not less than five) to join the Institute on the proposal of two or more Fellows, and producing "*evidence of fitness*."

I would further suggest that any pupil, articulated to a professional chemist of position, reputation, or F.I.C., on completing his time, be admitted to the "Associateship" on the recommendation of his Teacher and another, and at the end of one year be raised to the "Fellowship."—I am, &c.,

NON F.I.C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 20, November 16, 1885.

Theory of Freezing-Mixtures.—A. Potier.—When a cycle is non-reversible the mechanical theory of heat indicates in what direction it may be traversed, and the application of its principles is particularly simple when the transformations of which the cycle is composed take place at a constant temperature, as it has been pointed out by Moutier. In this case it is necessary that the result of the cycle consists in an expenditure of work on the body or the system in question which must give up an equivalent quantity of heat. If we consider a saline solution we may evaporate at a given temperature the water of the solution, condense it in the state of water or of ice (according to the temperature selected), and restore the water or the ice into contact with the salt. The total work to be expended in these operations is positive or negative according as the maximum temperature of the watery vapour of the mixture is smaller or greater than the maximum tension of the vapour in contact with the water or the ice. This work being positive the former tension is smaller than the second, a result well known in the case of liquid water, but which comprises also the theory of freezing mixtures. Hence we conclude that ice added in excess will melt in contact with salt or acid until the vapour tension of the resulting liquid is equal to that of ice at the same temperature. At zero the vapour-tension of ice is greatest, and fusion is therefore necessary. When the temperature falls the maximum temperature lowers more quickly for the ice than for the liquid, and there exists a temperature at which they are equal. This is the minimum temperature of the freezing-mixture.

Numerical Laws of Chemical Equilibria.—H. le Chatelier.—The author propounds the following laws:—The coefficient of the proportional variation of each body in contact is equal to the energy gained by the system, in the form of mechanical energy, from the disappearance of the body considered, during an infinitely small transformation of the system. The coefficient relating to temperature is the thermic energy gained under the same conditions.

Fixation of Atmospheric Nitrogen in Arable Soil.—H. Joulie.—The remarkable studies of M. Berthelot presented to the Academy in the sitting of October 26 decide the author to make known facts of the same class observed during the experiments on vegetation which he has been carrying on for several years. The results, which are given in the form of a table, show almost constantly a gain of nitrogen, the intensity of which, in one experiment, reached 0.577 grm. per kilo of soil.

Moniteur Scientifique, Quesneville.

Vol. xv., October, 1885.

French Association for the Advancement of Science: Meeting at Grenoble, August 12, 1885.—The three papers here inserted as having been read on this occasion are all of a purely medical character.

Influence of Light in Chemical Reactions, and especially in the Action of the Halogens upon the Aromatic Compounds.—Julian Schramm has recently published a study concerning the action of chlorine and bromine upon benzol and toluol. With benzol no difference is perceived whether we operate in full light or in the dark. With toluol, on the contrary, under the action of light the substitution of chlorine or bromine extends

only to the lateral chains, even if we work at the temperature of melting ice. These facts are known and have been for some time industrially utilised. When it is necessary to prepare, for the manufacture of malachite green, a very pure benzyle trichloride, and subsequently benzylene chloride, it is found that exceptionally good products are obtained, almost exempt from chlorine derivatives in the nucleus, by causing chlorine to act upon the toluol under the influence of the solar rays. This condition was first realised by passing the toluol in vapour through a series of glass pipes traversed by a current of chlorine well dried. It was soon observed that when the light is good it is not necessary to heat the chlorine to its boiling-point. Nevertheless this process, having the defect of depending on the clear or cloudy state of the weather, was abandoned until an active light could be procured at will by means of the electric ark.

The Utilisation of Sulphuric Acid which has served for the Purification of Coal-Tar.—The author proposes a combination of the processes patented respectively by Lowe and Gill, and by Gutzkow.

Determination of Glycerin in Aqueous Solutions and in Fats.—R. Benedikt and R. Zsigmondy.—This paper will be inserted in full.

Patents obtained Abroad.—The specifications here given in abstract are for the preparation of aluminium, the fusion of ores by means of electricity, the electric treatment of the zinc crusts obtained in de-silvering argentiferous lead by means of metallic zinc, for the preparation of bronzes of a high metallic lustre, for potash and ammonia soaps, for the preparation of a quinoleic base called antiphthysine (!) by the reaction of glyoxal upon ortho-diamido-anisol, and for the extraction of caoutchouc, wax, colours, and vegetable wool from *Sonchus oleraceus* and *Asclepias syriacus*.

Patents relating to Colouring-matters.—A selection of German patents.

Volumetric Determination of Manganese in Alloys Ores, &c., by means of Potassium Chlorate.—Prof. W. Hampe.—This memoir will be inserted as soon as practicable.

Discourse delivered by Mr. Perkin on assuming the Presidency of the Society of Chemical Industry.—From the *Journal of the Society of Chemical Industry*.

Patents taken out in France in the Chemical Arts.—A list of French chemical patents for the month of August.

Selection of Patents taken and published in France in 1885, having connection with the Chemical Arts.—This list also refers to August last.

Extraction of Alkaloids from Cinchona Barks by means of Dilute Acids.—Dr. J. E. de Vrij.—From the *Chemist and Druggist*.

New Reactions of Grape-Sugar and Milk-Sugar.—M. Rübner.—From the *Zeitschrift f. Anal. Chemie*.

Biedermann's Central Blatt für Agrikultur Chemie,
Vol. xiv., Part 6.

Beet-roots and Phosphates.—A. Ladureau.—Phosphoric acid soluble in water seems, in the author's experiments, to have had the same effect as precipitated phosphate.

Manurial Experiments in the Experimental Garden of the German Hop-Growers' Association.—Dr. C. Kraus.—Judging from the season 1883 superphosphate and cubic nitre occasion a considerable increase in the crop, the weather being suitable.

Further Researches on the Digestion of the Horse.—MM. Ellenberger and Hofmeister.—An investigation on the function of the pancreatic secretion, which appears capable of discharging the duties of the stomach in great

part or altogether. On the other hand, it is doubtful whether, in case of disease, the pancreatic digestion can be fully replaced by the activity of the saliva and of the juices of the stomach and the bowel.

Analyses of various Agricultural Produce in Japan.—Dr. O. Kellner.—Tables showing the composition of a variety of plants used in Japan for human food, or for the nutriment of cattle, &c.

Chemical Studies on the Development of the Eggs of the Silkworm.—A. Tichomiroff.—The chorion of the egg contains no chitine, and consists of chorionine, a peculiar substance containing sulphur: during their development the eggs lose more than 10 per cent of their total weight, becoming poorer in moisture, and even giving off a portion of their dry solids. The daily decrease of weight is proportional to the morphological differentiation. During development the eggs become poorer in insoluble albumenoids, glycogen, fat, and cholesterin, but richer in lecithine and peptones.

Cultivation of Maize, and its Preservation in Silos.—M. Rose.—The proportion of acetic and lactic acid found in such maize is 2 per cent.

Experiments on Feeding Cattle with Sugar.—G. Zimmermann.—In sheep no appreciable benefit was realised. In swine it was found advantageous, even at high prices of sugar. In calves the experiment occasioned violent diarrhoea.

Feeding with Unground Maize, Dry and Steeped.—M. Müller.—The dry maize showed an advantage: animals fed with it for ten weeks increased in weight on an average 3 kilos. per head more than others fed on steeped maize.

Occurrence of Allantoine, Asparagine, Hypoxanthine, and Guanine in Plants.—E. Schulze and E. Bosshard.—Allantoine and asparagine were detected in two successive years in the shoots of *Platanus orientalis*, *Acer pseudoplatanus*, and *A. campestre*. *A. pseudoplatanus* yielded 5 grms. asparagine and 0.5 gm. allantoine per kilo. of fresh shoots. A negative result was obtained on testing for allantoine in the shoots of *Betula alba*, *Fagus sylvatica*, *Tilia parvifolia*, *Populus nigra*, and *Vitis vinifera*, though asparagine was present in all. Etiolated sprouts of lupins and pumpkins yielded much asparagine, but no allantoine. Xanthine compounds (hypoxanthine, xanthine, guanine) were found in young potato-tubers, in beet-roots, in young plants of grass, clover, oats, and tares.

Assimilation of Atmospheric Nitrogen by Plants.—Prof. O. Atwater.—The author's experiments, unlike those of most authorities, give an affirmative result. In what manner free nitrogen is taken up Prof. Atwater leaves for the present undecided.

The Destiny of Sulphur during the Germination of Peas.—G. Tammann.—In fresh yellow peas only one-fifth of the sulphur present existed in the form of sulphuric acid, and there were also traces of sulpho-conjugated ether acids. In ten days, in darkness, the quantity of sulphuric acid had increased threefold. In another experiment, conducted in diffused daylight, the sulphur present in organic compounds was also oxidised to sulphuric acid. If the germination takes place in the daylight, greater quantities of ethero-sulphuric acids are formed than in darkness. The quantity of phosphoric acid in etiolated pea-sprouts was also found to increase.

Influence of Calcium Sulphide on the Growth of Barley.—Drs. Fittbogen, R. Schiller, and O. Förster.—The action of calcium sulphide (tank-waste, &c.) depends on the liberation of hydrogen sulphide.

Experiments in Electric Cultivation.—Prof. Holdeleiss.—Plates of copper were thrust into the earth in an upright position, and were connected by wires with zinc plates, in a similar position, at the distance of 33 metres. Both potatoes and beets between such plates gave an in-

creased yield—beets 15 per cent, potatoes 24 per cent—as compared with other parts of the same field.

Beets in the Shade and in the Open.—Dr. B. Lach.—In the earlier part of the season the roots in the shade were richer in sugar, but in the autumn the difference disappeared.

Experiments with Sorghum saccharatum.—Dr. Troschke.—This plant is worth attention as a source of sugar only in warm climates. In Germany it may be advantageously cultivated as a fodder crop.

Ærotropism of Roots.—H. Molisch.—The author's experiments do not lead to any explanation of ærotropism.

On Acid Putridity in Grapes.—K. Portele.—The cause of this affection is the caterpillar of *Tortrix uvana* or *Conchylis ambiguella*. The grapes attacked introduce morbid ferments into the must, and consequently into the wine, which is thus often completely spoiled.

On Lactic Fermentation and Organisms in Milk.—Drs. Hueppe, Engling, Escherich, and Bang.—Milk contains no chemical ferment forming lactic acid. The production of lactic acid is a true fermentation, due to *Bacillus lactis*. New milk does not contain the living bacillus, but its spores exist pre-formed in the milk-gland, and thus always arrive in the milk. *Bacillus lactis* is aerobic, and in the absence of oxygen no lactic fermentation is possible. The mature bacillus perishes below 100°, but the spores are still capable of conversion into living rods unless exposed to 110° for forty minutes.

Vol. xiv., Part 7.

Occurrence of Sulphuric Acid in the Atmosphere.—G. Witz.—From the *Comptes Rendus*.

Researches on the Humoid Bodies obtained from Peat.—Dr. L. Sostegni.—By treating humic acid with alcohol there are obtained two bodies distinct in composition. The portion soluble in alcohol is less lustrous and less hard when dry, and slightly hygroscopic. The difference between Mulder's ulmic and humic acid, and the difference of the bodies obtained by Ditmer from peat, seems due to the compounds obtained by the author.

On Nitrification.—R. Warington.—From the *Journal of the Chemical Society*.

Ammonia or Bolivian Nitre.—Prof. Märcker.—The author considers that the ammoniacal salts cannot compete with soda saltpetre until they are decidedly cheaper, so as to permit the use of a greater quantity of nitrogen for the same money.

On Wool-dust, Tanner's Waste, Oil-cake, and Osmose-waters.—Prof. Wagner, Dr. Stutzer, and A. Barth.—The Belgian woollen-mills send out yearly 20 million kilos. of shoddy dust. In 29 samples examined by Wagner the nitrogen ranged from 1.51 to 10.40 per cent. The author values the nitrogen in wool-dust which has not been rendered soluble at 45 to 50, or at the utmost 60, pfennige per lb.—nitrogen in soda-nitre, and in ammoniacal salts, being worth 80 to 90 pfennige (100 German pfennige = 1 mark). The valuable contents of tanner's waste are given as per "eimer" full, the weight not being stated. The ash of spent tan, when burnt alone, contains mere traces of the very injurious ingredients, calcium and iron sulphides. Oil-cake powder was found to contain—nitrogen 4.22, phosphoric acid 1.8, and potash 0.8 per cent.

Manurial Experiments with Potassium Chloride.—D. Zolla.—The results with lucerne, oats, and wheat were decidedly favourable.

The Influence of Different Methods of applying Manures.—Dr. C. von Tautphöus and Prof. E. Wollny.—Softening the seed in saline solutions has merely the same influence as steeping in pure water, provided the liquid is not *per se* injurious,—i.e., in many cases the

germination is accelerated and the crop increased. Coating the seeds with manurial matter retards germination, and decreases the number of seeds which come up. The influence on the crop is very fluctuating. Manuring the seed in either of the methods above mentioned can never take the place of ordinary manuring. The application of manures in rows, as compared with an equal distribution over the whole field, gives fluctuating results, and is not generally preferable. "Hole-manuring" for potatoes and "root-manuring" for beets, &c., do not give satisfactory results.

Valuation of Hays.—F. Schindler.—The author determines botanically the plants existing in an average sample, and values the hay higher or lower according as sweet grasses and leguminous plants, or, on the other hand, sour grasses and weeds, predominate.

The Albumenoids of Cow's Milk.—J. Sebelien.—The author distinguishes here lacto-globuline and lact-albumen. The former of these bodies is perhaps identical with the paralbumen of the blood. Lactalbumen agrees with serum-albumen except in its optical rotatory power, which is considerably feeble. It cannot be regarded as a modification of caseine.

Expiration of Carbonic Acid and the Absorption of Oxygen by Leaves kept in Darkness.—MM. Dehérain and L. Maquenne.—From the *Comptes Rendus*.

The Activity of Chlorophyll distinct from Respiration.—G. Bonnier and L. Mangin.—From the *Comptes Rendus*.

Theory of the Movement of Water in Plants.—Prof. Emil Godlewski.—The living cells maintain the movement of water in plants.

On Selective Alcoholic Fermentation.—E. Bourquelot.—From the *Comptes Rendus*.

Bulletin de la Société Chimique de Paris.

Vol. xlv., No. 8, Nov. 5, 1885.

On a New Neutral Magnesium Carbonate.—R. Engel.—Already noticed.

Action of Potassium Bicarbonate upon Magnesium Neutral Carbonate and Bicarbonate.—R. Engel.—The product of the reaction is the double potassium and magnesium sesquicarbonate.

The Magnesia Industry.—Th. Schloesing.—Already noticed.

Dr. Ferran's "Cholera Vaccine."—Drs. Chantemesse and Rummo.—In a paper read before the Academy of Medicine by the former of these gentlemen they describe the examination of, and the experimental results obtained with, two samples of this vaccine, the one brought from Spain by M. Rummo, and the other sent directly by Dr. Ferran. The results of their investigations are that this vaccine is not a culture liquid of constant composition. Sometimes it is an impure culture of comma-bacilli and sometimes a liquid containing masses of micro-organisms, whilst the comma-bacillus is nearly absent. In either case the subcutaneous introduction of this so-called bacillus does not protect against the introduction into the stomach of a pure culture of the comma-bacilli made by known methods. Its protective power has been found null in our experiments. If injected underneath the skin of guinea-pigs, even in the dose of several c.c., this vaccine produces no chloroform phenomena. According to its composition and the dose injected it sometimes produces local sores and sometimes remains inoffensive. If cultivated separately the various micro-organisms found in the liquid possess different pathogenous powers, and in considerable doses some of them occasion death.—*Moniteur Scientifique*.

NOTES AND QUERIES.

* * Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Soap.—If French chalk or powdered talc has been put in soap, how can I detect it?—IMPORTER.

Turpentine.—How may turpentine be detected in essential oils? Is there any way of determining roughly or otherwise its percentage?—READER.

MEETINGS FOR THE WEEK.

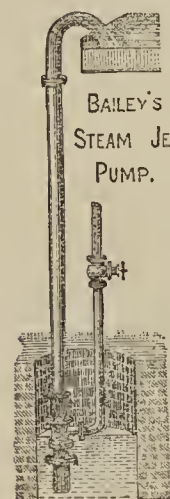
- MONDAY, 7th.—Royal Institution, 5. General Monthly Meeting.
 — London Institution, 5.
 — Society of Arts, 8. (Cantor Lectures,) "The Microscope," by John Mayall, Jun.
 — Medical, 8.30.
 TUESDAY, 8th.—Institution of Civil Engineers, 8.
 — Royal Medical and Chirurgical, 8.30.
 — Photographic, 8.
 WEDNESDAY, 9th.—Society of Arts, 8. "The Loadlines of Ships," by Prof. Francis Elgar, LL.D., F.R.S.E., M.I.C.E.
 — Pharmaceutical 8.
 — Microscopical, 8.
 THURSDAY, 10th.—Royal, 4.30.
 — London Institution, 7.
 — Royal Society Club, 6.30.
 — Mathematical, 8.
 FRIDAY, 11th.—Quekett Club, 8.
 SATURDAY, 12th.—Physical, 3. "On Some Thermo-dynamical Relations," by Prof. William Ramsay, Ph.D., and Mr. Sydney Young, D.Sc.

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THE CHEMICAL NEWS.

VOL. LII. No. 1359.

THE ESSENTIAL CHEMICAL ELEMENTS OF PLANTS.*

By THOMAS JAMIESON.

THE question "What food do plants require?" is gradually receiving a shorter and simpler answer.

To meet the object of this paper it is not necessary here to go back to the time when *natural soil* was deemed essential to plant growth, nor to the less remote period when those indefinite *organic* substances that are usually present in soil were supposed to be in some way or other necessary; nor need we go back even to the comparatively recent period when all the matters that are invariably found in plants, when analysed, were regarded as indispensable. It is now well known that many experiments (prominent among which are those by Sachs, Stockmar, Wolff, Knop, and Nobbe) have shown that several of the substances that are usually found in plants are not really required,—in other words, that certain ingredients are *essential*, while others are merely *accidental*.

We thus reach the present period, when the essential food of plants is believed to consist of, at most, eleven elementary substances, viz., carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, chlorine, and iron.

The special object of this paper is to approach the question whether the reduction in the number of essentials has reached its utmost limit, and to present experiments that go some way to show that a further reduction of the essentials seems demanded.

In regard to the first four of these elements there appears to be no room for doubt, and they may therefore be passed over with a brief allusion.

Of these the first three elements—viz., carbon, hydrogen, and oxygen—are so prominently important that, in any treatise on plants they demand by far the largest share of attention, but as a rule they receive less notice than the minor elements, probably for the reason that Nature undertakes almost the entire supply.

These three elements might be classed as a separate group by reason of two characters:—

- I. That it seems self-evident that they are essential to plants, from the fact that plants consist chiefly of compounds which are well known to be composed of definite or atomic proportions of carbon, hydrogen, and oxygen,—viz., sugar, starch, oil, gum, &c.
- II. That there is in Nature an abundant and suitable supply of these elements in the form of carbonic anhydride and water.

Nitrogen holds an intermediate position between the group just considered and the group to follow, inasmuch as it resembles carbon, hydrogen, and oxygen by forming part of one of the constant products of plants, viz., albumen, and existing in it always in such definite proportions as to preclude the possibility of the plant being developed without it; while unlike these three elements, it is not provided in a suitable form by Nature in sufficient quantity for full and rapid development of cultivated plants. Hence it forms one of the main ingredients that have to be supplied under the name of manure, and consequently it has always received the major part of attention. It is apart from the object of this paper to refer to those subjects which have given rise to so many experiments and

discussions, viz., the natural sources of nitrogen that are directly at the command of the plant, and the merits of different artificial forms of nitrogen. It suffices for the present purpose to know that nitrogen is absolutely essential.

The third and last group of seven elements is the one to which attention is here specially directed. The elements comprising it are characterised by existing in plants in so inconstant and often insignificant proportions as not to convey a conviction, based on proportionate quantity, that they are essential.

Further, if they form any part of the organic compounds in plants, they do not, so far as is known, seem to enter into them in the definite chemical ratio that can be expressed in a chemical formula. Each element may thus be called upon to prove its right of admission, as it were, into the essential group.

Phosphorus is undoubtedly the most important member of this group. Many experiments, more or less specially directed to answer the question whether or not phosphorus is essential, have shown, more or less clearly, that it is essential; and within the last few years an opportunity was afforded me, in conducting the experiments for the Sussex Association for the Improvement of Agriculture, to add a few striking confirmations of this fact.

The analysis of the sand used as soil brought out that 99½ per cent is composed of matter insoluble in 50 per cent boiling hydrochloric acid, and hence it may safely be assumed that this large proportion is totally beyond the command of the plant. When to this proportion is added the organic matter, the iron, and alumina, there is left about ¼ per cent, or 1 part in 1000, of possible plant food, and this minute proportion is chiefly made up of lime and magnesia. The phosphoric anhydride, it is important to observe, is under 1 part in 10,000, equal to 1 part of phosphorus in about 23,000 of soil. The sand was thus practically destitute of plant food. While fortunately its mechanical consistency was such as to retain moisture well, it was neither plastic and dense, nor too open and loose, and hence formed a very suitable medium to perform the experiments on.

Uniformity in the composition of the plots was secured by carting it into large mounds, and mixing it repeatedly. A degree of precision is thus reached that permits of very small plots being used with accuracy, just as minute quantities are with accuracy acted on in a chemical analysis. The thousandth of an acre is a most convenient size under such circumstances. Without such precautions, but on a patch of ground as nearly equal in all respects as can be known, about one-hundredth of an acre must be acted upon. When the size of plot goes beyond this, the results must probably be regarded with the suspicion that the comparisons may not be reliable, owing to different conditions of soil and subsoil, and more especially to cultivation under different climatic conditions, which affect crops so considerably. For instance, part of a field sown with turnips during a slight shower has been found not to yield one-half of the crop grown on the neighbouring soil of the same field, sown on the same day, but before the shower. As 10 comparisons of 1-1000th acre cover only 1-100th acre, each cultivation treatment extends over so short a time that no climatic disturbant enters; while 10 comparisons of ¼ acre is equal to 2½ acres, over which the cultivation is likely to extend for several days. It is rare in our variable climate to get three successive days identical in regard to weather, and consequently the possibility of identical treatment is reduced to a chance.

Twelve of the plots were then supplied with a uniform mixture containing all the ingredients understood to be essential to plants, except those three that are supplied abundantly by Nature, and except also phosphorus. Phosphorus, however, in various forms, was then applied to ten of these twelve plots, and withheld from the remaining two. In those two plots from which phosphorus had been withheld the plants absolutely refused to grow beyond the first few leaflets, and made only abortive

* Abstract of a Paper read before Section B, British Association, Aberdeen Meeting.

attempts to form a bulb. All the other plots gave a full crop. The results were as follows:—

Turnips (Water extracted).

	Form of Phosphate.					
	Copro- lite.	Bone Ash.	Super- phosphate.	No phos- phate.	Steamed Bone Flour.	S.B. Fl'r and Co- prolite.
	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.
Principal	71'29	87'49	95'68	4'12	86'67	79'56
Duplicate	94'58	84'25	79'36	3'09	84'01	80'04
Average	82'93	85'87	87'52	3'60	85'34	79'80

The experiments were conducted with certain modifications for other four years in the same plots, and practically identical results were obtained yearly. (In all the experiments the results were checked by a duplicate plot, as shown in the above figures; but in the subsequent tables, for clearness sake, only the average is given.) Strong evidence is thus provided that phosphorus is absolutely essential.

Next in importance to phosphorus comes potassium. Similar experiments in reference to this element gave results similar to those found in the case of phosphorus, but the decrease in the crop when potassium was withheld was not nearly so great as when phosphorus was withheld. It was only in the case of peas that any decrease resulted; in the case of turnips the first year there was little or no decrease. This was probably due partly to the traces of potash in the soil and partly to the probable fact that potassium is not so dominant an element in plants as phosphorus. The following are the results for the first year:—

Peas.

Potassic carbonate	.. .. .	30 ozs.
„ sulphate	.. .. .	33 „
„ chloride	.. .. .	1* „
„ phosphate	.. .. .	33 „
„ nitrate	.. .. .	47 „
No potash	.. .. .	21 „
No manure	.. .. .	3 „

Turnips.

Potassic carbonate	.. .. .	36'5 ozs.
„ sulphate	.. .. .	40'69 „
„ chloride	.. .. .	0*
„ phosphate	.. .. .	40'52 „
„ nitrate	.. .. .	72'94 „
No potash	.. .. .	38'59 „
No manure	.. .. .	0 „

In the following year (1882) the experiments were repeated in the same plots, and the differences were more marked, especially in the case of turnips; that is to say, good crops were got where potassium had been given, and very poor crops where it had been withheld. Not only were the final weights less where potash was withheld, but the plants seemed unhealthy, especially in the leaves, which were short, thick, twisted, and leathery-like. The following are the results:—

Peas.

Potassic carbonate	.. .. .	37½ ozs.
„ sulphate	.. .. .	41½ „
„ chloride	.. .. .	9½*
„ phosphate	.. .. .	34½ „
„ nitrate	.. .. .	33½ „
No potash	.. .. .	19½ „

* A remarkable result is shown above in regard to potassic chloride, but not to break the continuity of the subject of the essential food of plants, detailed reference to this circumstance is deferred. The large result from potassic nitrate is due to the large proportion of nitrogen of necessity given in supplying potash in this form.

Turnips.

Potassic carbonate	.. .. .	48 ozs.
„ sulphate	.. .. .	52 „
„ chloride	.. .. .	55 „
„ phosphate	.. .. .	55 „
„ nitrate	.. .. .	62 „
No potash	.. .. .	19 „

A very interesting, and, as it turned out, very instructive, modification was made in the third year in this set of experiments. The two plots of both the pea and turnip series from which potassium had been withheld were each divided, thus forming eight half plots. From four of these halves potassium was still withheld; to other two halves potassium was given; and to the remaining two halves soda was given. Conditions were thus established to secure positive results side by side with the repetition of negative results. The experiments were thus calculated to show whether, on the one hand, the addition of potassium would cause the crops of turnips and peas to leap up to the line of the full crops, and, on the other hand, whether sodium, which resembles potassium so closely, could take the place of potassium. The results were sharp and decisive. The crops leapt up remarkably on the potassium halves, and remained stationary both in the nothing halves and in the sodium halves. By these and the previous experiments it thus seemed proved, first, that potassium is absolutely essential, and, second, that whatever function is performed by potassium it cannot be performed by sodium. The following are the results:—

Peas.

Potassic carbonate	.. .. .	54 ozs.
„ sulphate	.. .. .	59 „
„ chloride	.. .. .	65 „
„ phosphate	.. .. .	47½ „
„ nitrate	.. .. .	64½ „
No potash	.. .. .	12½ „
Potas. carb. (previously no potash)	.. .. .	64 „
Sodic carb.	.. .. .	12 „

Turnips (in Wet State).

Potassic carbonate	.. .. .	54 lbs.
„ sulphate	.. .. .	53 „
„ chloride	.. .. .	60 „
„ phosphate	.. .. .	63 „
„ nitrate	.. .. .	53 „
No potash	.. .. .	10 „
Potas. carb. (previously no potash)	.. .. .	68 „
Sodic carb.	.. .. .	6 „

The information derived from the preceding experiments is merely confirmatory; the facts brought out were previously more or less unanimously accepted, and we have here merely convincing proofs of a satisfactory kind, which were perhaps not altogether unnecessary.

We now, however, approach evidence suggestive of a reduction in the accepted number of essentials, by the rejection of one or more ingredients which are generally supposed to be necessary.

The peculiar opportunity presented by the pure and congenial soil at command invited the testing of several of the other ingredients that are deemed essential in the anticipation of similar, though probably less marked, results. The first results, however, turned out very different from the anticipation that had been formed. They are as follows:—

Turnip Crop (in Wet State) Manured with Purest Manure.

Phosphorus withheld	.. .. .	½ lb.
Sulphur withheld	.. .. .	31 lbs.
Nitrogen withheld	.. .. .	½ lb.
Everything withheld	.. .. .	½ „
Magnesia withheld	.. .. .	34 lbs.
Potash withheld	.. .. .	15 „

A more complete set was simultaneously started, but using pure chemical salts as manure.

Turnip Crop (in Wet State) Manured with Pure Chemical Salts.

Phosphorus withheld	$\frac{1}{10}$ lbs.
Sulphur withheld	51 "
Nitrogen withheld	6 "
Everything withheld	$\frac{1}{10}$ "
Nothing withheld	42 "
Magnesia withheld	49 "
Potash withheld	11 "
Lime withheld	55 "

These two sets of experiments had not proceeded far when it became obvious that some of the elements that are deemed essential are not essential, or exercised no effect in the early stage of the growth, or that the plants were finding a sufficiency of these elements in the soil.

In other words, they seemed to indicate that sulphur, magnesium and calcium are not essential, or at least seemed to raise some doubt on that point. For the withholding of sulphur, magnesium, and calcium did not lessen the crop in any degree: on the contrary, the crops grown without them slightly exceeded the crop from which nothing had been withheld, as if the giving of sulphur, magnesium, or calcium to that plot had done injury. That the "Lime withheld" plot should turn out so well may, to some little extent, be explained by the fact that the experimental station is only three miles from the chalky downs, and that breezes might have conveyed traces of lime, which, added to the traces already in the soil, might have sufficed. It should also be added that on two occasions it was found necessary to water the plants, and that this water contained some sulphates of lime and magnesia. It seemed hardly likely, but it may be possible, that these circumstances might account for some proportion of the large crop got when lime and magnesia were withheld, but they could scarcely account for the heavy crop where sulphur was withheld.

In consequence of the waterings above referred to, a third series was, later on in the same year, established on new ground, and also manured with pure chemical salts. The season was too far advanced to admit of having good crops and large differences, but the differences, such as they were, went clearly in the same direction as those of the former trials; that is to say, tending to minimise the influence of lime, magnesia, and sulphur on plant growth, and seeming to throw some doubt on the accepted doctrine that they are essential. The suspicion seemed still stronger against sulphur when actual analyses of the turnips gave the following results:—

	Sulphuric Anhydride. Per cent.	Calcium. Per cent.	Magnesium. Per cent.
Plant from plot from which nothing was withheld con- tained	0.055	0.083	0.042
Plant from plot from which calcium was withheld con- tained	0.028	0.081	0.041
Plant from plot from which magnesium was withheld contained	0.089	0.088	0.042
Plant from plot from which sulphur was withheld con- tained	0.012* none†	0.088	0.038

* First bulb. † Second bulb.

It thus appears from these figures that the calcium and magnesium are present in nearly equal quantities, and have in some way got into the plants apart from the manure, while the sulphur fluctuates as accidental substances generally do, but, in particular, it was absolutely absent in one of the turnips grown in the "sulphur withheld" plot.

Here, then, we have two facts: first, that a large crop was produced in a soil containing no sulphur, or only traces of it, and to which no sulphur was given in the manure; and, second, that the fully developed turnips thus grown gave on analysis no sulphur whatever. As regards calcium and magnesium, they having been found in the turnips, the evidence against them is weakened.

Obviously, the longer that these plots were treated in a similar manner the better would they be suited to answer the same question, inasmuch as the disturbing traces in the soil would be gradually eliminated. The experiments were therefore repeated in the same plots in the following year, but in a modified form; that is to say, those plots which refused to yield produce when certain elements were withheld (viz., nitrogen, phosphorus, and potassium "withheld" plots) had now that element supplied to them in the expectation that the crop would leap up to the normal position. This actually took place. The other plots (viz., the sulphur, magnesium, and calcium "withheld" plots), which had given good crops, had their respective elements still withheld, so that the evidence of their non-essential character would be strengthened or weakened according as there was a full or a deficient crop. Substantially, the evidence of their non-essential character was strengthened; the crops were good in each case. The following are the results:—

Turnip Crop (in Wet State).

Phosphorus given	44 lbs.
Sulphur still withheld	39 "
Nitrogen given	23 "
Everything still withheld	25 lbs.
Magnesia still withheld	35 "
Potash given	37 "

Turnip Crop (in Wet State).

Phosphorus given	44 lbs.
Sulphur still withheld	36 "
Nitrogen given	27 "
Everything still withheld	2 "
Everything again given	31 "
Magnesia still withheld	31 "
Potash given	33 "
Lime still withheld	31 "

The general result seems to foreshadow the exclusion of sulphur, magnesium, and calcium from the list of plant essentials, and to call for other experiments by other experimenters under such varied conditions as will settle the point.

Numerous experiments were simultaneously carried out in larger plots of ordinary soil of different kinds, namely, chalky soil, clay soil, and clayey loam. The results need not here be stated particularly, as it might complicate, and also because the soil being impure the results cannot be regarded as so reliable; but the general character of these results got on ordinary soils go far to prove what seems to be so well demonstrated by the pure sand experiments.

The remaining two elements supposed to be essential, —viz., chlorine and iron,—exist in plants in so infinitesimal proportions that it is doubtful whether, indeed, their admission into the list of essentials is fully acquiesced in. To eliminate such traces of ever-recurring substances would require a special kind of experiment, which I have not yet been able to carry out.

In a sentence reference might be made to collateral evidence by considering the subject of function. Regarding the plant as the natural food of the animal, and it being certain that lime is essential to the animal to form bone, and it being at least possible that sulphur and magnesia are necessary to animals, it might be assumed that this affords ground for supposing that plants, being the natural food of animals, will contain all the elements that are essential to animals, and that hence what is essential to animals will be essential to plants, for at first glance it may seem that in no other way could it be ensured that

animals would be duly supplied with their requirements. But while plants form the natural food of animals, water is their natural drink. Now water never is pure in nature, and it is significant that its usual impurities are just those that we have seen have failed in those experiments to prove their right of admission into the list of plant essentials, viz., sulphur, magnesium, and calcium.

In hundreds of waters analysed by the experimenter it has been found almost without, if not quite without, exception that the largest proportion of the solid matter in solution is composed of sulphates of lime and magnesia, from which animals would naturally obtain those essentials that do not appear to be essential to plants. Any substance present in plants and not wanted must be regarded as in the way. But some of these may be practically harmless and others hurtful.

This seems the proper place, therefore, to allude to the peculiar results obtained by the use of potassic chloride. The plants were actually killed, the symptoms being such as directly pointed to the action of free chlorine. The leaves were markedly blanched throughout in an early stage of growth, and ultimately the plants died. The explanation seems to be that decomposition of the potassic chloride had taken place, probably within the plant, the plant seizing the potassium which was essential to it, and liberating chlorine, which exerted its bleaching and poisonous influence.

A curious circumstance, however, is that in repeating the potassic chloride experiments in expectation of getting the same result, that result was not obtained in nearly so decisive a manner; for after suffering slightly for a time the plants revived, and although in the case of peas only a light crop was yielded, there was in the case of turnips a heavy crop. The difference in result was probably due to a difference during the early stage of growth in the proportion of moisture in the soil, or of the rainfall, which would have the effect of lengthening the time of admission of potassic chloride into the plant until it was able to resist its evil influence; in other words, of so regulating the rate of admission as not to have so injurious an effect. A somewhat similar effect was shown in the case of potassic sulphate, but instead of a blanching the leaves were slightly reddened as if by free acid. By-and-bye, however, they recovered, and an average crop was produced. In this case probably sulphuric acid had been liberated, causing the reddish tint which is always produced by acids, but the circumstance that chlorine and sulphur under certain circumstances exert such evil influences seems to strengthen the contention that they are not essential.

A large number of experiments performed years ago in Aberdeenshire seem to point plainly to the pernicious effect of sulphur. The following is a summary of a few of the results. The plots were commenced in 1878, were manured yearly, and turnips sown yearly. In 1880 disease set in, but it was confined in great measure just to those plots which had got manure containing sulphur.

Original number of plants in plot ..	300
	Number of Diseased Plants.
And the result by the application {	297
of manure containing sulphur. {	296
	272
Ditto, ditto, ditto, containing less {	218
sulphur. {	197
Ditto, ditto, ditto, containing no {	89
sulphur. {	85
	74

In the following year the average number of diseased bulbs was as follows:—

	In Loamy Soil.	In Clay Soil.	In Sand Soil.
After complete manure containing sulphur	285	264	121
After manure containing no sulphur	51	46	33

The disease is a fungoid one, caused by the fungus *Plasmodiophora brassica*, and it is supposed that the sulphur predisposes to disease by merely weakening the plants, just as great excess of moisture, drought, or other evil influence lessens the resisting power of the plant in contending with its natural enemy.

It remains only to say that, although unfortunately this sand station is not at our command for continuing the same experiments on the same ground, a neighbouring site has been obtained, and the experiments are again being conducted on a similar plan with the same care.

ON THE FLUORESCENCE OF THE RARE EARTHS.

By M. LECOQ DE BOISBAUDRAN.

SINCE sending his last note Mr. Crookes has examined some of my products, and has made experiments which he has confided to me to bring before this Academy, with a courtesy of which I am more sensible as our opinions differ on several points.

I will commence by completing, or rather explaining, certain passages in my sealed packet which was opened at the meeting of the 8th of June last.

"1st. It has been printed (page 1437, line 14) that I observed the spectrum of fluorescence, with several of my assistants (*prepareurs*); this should read—with several of my preparations (*preparations*). Nearly all the samples of the earths of the yttria group that I have examined have really given this fluorescence, more or less marked.

"2nd. When I had only obtained feeble fluorescences, I feared that strictly calcium had something to do with the production of the red band $91\cdot75$; it has not: this band is caused only by the earth.

"3rd. The band $104\cdot9$ appeared to me to be, relatively to the band $115\cdot2$, a little more feeble with the earths less soluble in potassic sulphate. This has since been verified. The band 105 gains on 115 as I approach the head of the fractionations with ammonia.

"4th. I have confirmed my previous opinion, that the bands 105, 115, &c., are not due to Di, Er, Ya, La, Tu, Yb, Yt, Ce, Sc, Th, Zr.

"5th. Neither $Z\alpha$ nor $Z\beta$ can be considered as identical with the *new** decipium (announced by M. Delafontaine). This latter body should, according to the properties ascribed to it by the author, be found with Ya and Sm (see the note by M. Delafontaine, *Comptes Rendus*, July, 1881, p. 64).

"6th. The fluorescence of the earths is apparent without reversing the poles (*i.e.*, leaving the liquid negative); but then it is not so fine, and, above all, it is partially hidden by spectra of an altogether different kind. To obtain a brilliant fluorescence the hydrochloric solution should be very acid, not syrupy, and not warmed by the passage of a prolonged current.

Examination of Mr. Crookes's Earths.

"Earth A contains a good deal of Di and Sm, with a very noticeable proportion of Ya, as well as a very small quantity of Yt, Ho, and Er.

"Earth B contains principally yttria, with only a little Di, Er, and Ho.

"Earth C contains much yttria (but less than B), tolerable quantities of Er and Ho, and very little Sm, Ya and Di. This earth is of a distinct yellowish orange colour."

My process of reversion gives—

"With A a fluorescence spectrum, well marked, comprising (besides the bands which are of special interest) the orange band of Sm.

* Old decipium has been found by M. Delafontaine to be constituted of a mixture of *new* decipium, samarium, &c.

"With B the fluorescence is much weaker, the Sm band being absent.

"With C the fluorescence is again very superior to that of A; the Sm band is not appreciable."

To sum up: the fluorescence by reversion of hydrochloric solutions becomes finer the more the substance resembles the terbium earths. The sample richest in yttria is the least fluorescent.

In the state of solid sulphates *in vacuo* the same earths gave Mr. Crookes the following results:—

"A mixture of A with a little lime gave pretty brightly the spectrum that Mr. Crookes has shown to be characteristic of bodies containing both Sm, Yt,* and Ca.

"B gives a very good spectrum of Yt,* such as Mr. Crookes has already described.

"C gives again the citron and green bands, but much less intense than with A, or above all than with B."

To sum up: the fluorescence of the solid sulphates is more intense as we use a body poor in earths of the terbium class. The salient fact which one deduces from these observations is, that the results obtained by the two methods are exactly the opposite.

Examination of my Earths.

"Earth A is composed nearly entirely of yttria, but there are also traces of Ho, and very feeble ones of Er and Di. This earth is white, with a less pronounced yellow tinge than in Mr. Crookes's earth B.

"Earth B contains much Er and Ho. Erbium is still more abundant than holmium. There is also a noticeable quantity of Tu, a little Yt, as well as traces of Yb.

"By my method of reversion we get—

"With A a very feeble fluorescence, the green band only being thoroughly visible.

"With B the fluorescence is very distinct, the band 105 being well marked."

Summing up, the fluorescence of solutions is much better for substances which contain the least yttria.

In the states of solid sulphates *in vacuo*, the same earths gave Mr. Crookes the following results:—

"A gives a very fine fluorescence (Yt spectrum of Mr. Crookes).

"The simple sulphate of B shows only traces of fluorescence, but the sulphate of the mixture of B with lime gives a very strong fluorescence, although inferior to that of A. The citron band is the strongest; it has not, however, the strong line with sharp edges like the citron band of A."

To sum up: the fluorescence brilliant with the substance very rich in Yt hardly exists with the other, but it is developed in a remarkable manner with the latter by the addition of lime. Here again the two methods give opposite results.

My earths A and B have further been examined by M. Becquerel (in the form of different solid salts with or without lime), who has exposed them to the action of a powerful violet light. Under these conditions a fluorescence was produced apparently similar to that obtained in the Crookes tubes. The analogy of these two phenomena is found in this fact, that the earth A (the richest in Yt) gave M. Becquerel the best fluorescence.

The light of a powerful condensed induction-spark striking between two platinum poles, close to but not in contact with a hydrochloric solution of rare earths, causes fluorescence, as well as letting a weaker non-condensed spark play on the liquid itself. M. Becquerel suggested this experiment to me.

The following is a curious observation which has just been made by Mr. Crookes:—Having mixed my earths A and B in equal portions, he noticed that the mixed sulphate is hardly fluorescent *in vacuo*. The fluorescence of A, previously so fine, is thus destroyed by the presence

of B. The mixture behaves almost like B. There is, however, this interesting difference, that the addition of lime to the mixed sulphate produces a weaker fluorescence than is obtained with B+CaO. Thus not only B feebly fluorescent hides A, but A+CaO, so brilliant alone, diminishes the fluorescence of B+CaO, at the same time losing its own. This is in effect mutual extinction, analogous to that which Mr. Crookes noticed with mixtures of samarium and yttria.

In the presence of the strong fluorescence of the sulphates of my earth A and of Mr. Crookes's earth B, as well as of the feeble reaction obtained under the same condition by means of earths of the terbium group, which, on the contrary, give beautiful spectra by reversion, one is naturally led to make some hypotheses to try and explain the singular anomalies that I have just described. These hypotheses, which are nothing more than simple questions necessarily posed by the result of experiments, take different forms, according as we consider yttria as the primary cause of fluorescence, as Mr. Crookes maintains, or whether we attribute it to other substances, according to my opinion. The eminent English chemist has been good enough to let me know the conclusions that his latest observations have suggested to him, and the arguments which appear to him possible to bring forward in favour of the fluorescence of yttria,—arguments which he expressly states only to bring forward with the greatest reserve, and which, on the other hand, I should have brought forward myself, so strongly are they indicated by the facts observed, except to develop the contrary reasons which make me think that yttria is not the efficient cause of fluorescence. The narrow limits of this note do not allow me to-day to open this discussion, which will be, if the Academy so wishes, the subject for another communication.

M. de Boisbaudran announced (to secure the date) that he had obtained yttria giving only a very feeble fluorescence in Crookes's tubes.—*Comptes Rendus*, Sept 7, 1885.

NEW RESEARCHES ON THE COMPOUNDS OF DIDYMIUM.*

By P. T. CLEVE.

(Concluded from p. 279).

Acetate of Didymium.

I. $\text{Di}_3\text{C}_2\text{H}_3\text{O}_2 + \text{H}_2\text{O}$. On evaporating on a water-bath a solution of oxide of didymium in acetic acid fine needles of red colour are deposited.

0.5467 grm. gave by ignition 0.2699 grm. Di_2O_3 .
0.7621 grm. gave 0.3765 grm. Di_2O_3 .

			Calculated.	
Di_2O_3 ..	49.37	49.40	166	49.26
$\text{C}_4\text{H}_6\text{O}_3$..	—	—	153	—
H_2O ..	—	—	18	—
			337	

II. $\text{Di}_3\text{C}_2\text{H}_3\text{O}_2 + 4\text{H}_2\text{O}$. It crystallises at a temperature of about 15° in large, well-formed tabular crystals, which lose at 110° $3\text{H}_2\text{O}$ (found 13.84, calc. 13.81).

1.250 grm. gave 0.0533 grm. Di_2O_3 .

In per cent—

			Calculated.	
Di_2O_3 ..	..	..	42.64	166
$\text{C}_4\text{H}_6\text{O}_3$ ..	..	..	—	153
H_2O} ..	..	..	—	72
				391

* Mr. Crookes here assuming that the bands 104.9, 115.2, &c. belong to yttria.

* Presented to the Royal Society of Sciences of Upsala, March 20, 1885.

Specific gravity of the anhydrous salt—

0.9095 grm., t° 16.5°, sp. gr. 2.190
 0.8750 " " 13.5° " 2.125
 Molecular volume, 150.1.

Specific gravity of the monohydrated salt—

1.0219 grm., t° 20°, sp. gr. 2.230
 0.7688 " " " 2.244
 Mean of both determinations, 2.237.
 Molecular volume, 150.6.

Specific gravity of the tetrahydrated salt—

0.6909 grm., t° 13.5°, sp. gr. 1.884
 1.0874 " " " 1.881
 Mean of both determinations, 1.882.
 Molecular volume, 207.8.

The anhydrous salt, used for the determinations, was perfectly soluble in water, and gave on spontaneous evaporation crystals of the salt II. It is very remarkable that the specific gravity of the anhydrous salt was found lower than that of the monohydrated salt.

Crystalline form of II. asymmetric :

$$a : b : c = 1.91305 : 1 : 2.21946.$$

$$\alpha = 90^{\circ} 19' 40''; \beta = 104^{\circ} 33' 50''; \gamma = 90^{\circ} 19' 20''.$$

Planes: ∞P ; ∞P ; ∞P ; P ; P ; P ; P . (C. Morton).

Propionate of Didymium, $\text{Di}_3\text{C}_3\text{H}_5\text{O}_2 + 3\text{H}_2\text{O}$.

Dilute propionic acid dissolves the oxide of didymium, and the solution deposits on evaporation at the ordinary temperature violet prisms, which are tolerably soluble in water. They lose their water of crystallisation slowly in the air.

0.3300 grm. of the crystallised salt lost at 100° 0.0430 grm. and left on ignition 0.1322 grm. Di_2O_3 .

0.7070 grm. lost at 100° 0.0925 grm. and left 0.2844 grm. Di_2O_3 .

0.3327 grm. gave on combustion 0.1554 grm. H_2O and 0.3196 grm. CO_2 .

In per cent—

				Calculated.	
Di_2O_3..	..	40.06	40.23	166	40.00
C..	..	—	—	26.20	26.02
H ..	..	—	—	5.19	5.06
O..	..	—	—	120	—
				415	
H_2O} ..	..	13.03	13.03	54	13.01

Specific gravity of the crystallised salt—

0.6218 grm. t° 12.5°, sp. gr. 1.741
 0.6465 " " 13° " 1.742
 Molecular volume, 238.4.

Specific gravity of the anhydrous salt—

0.5351 grm. t° 12.5°, sp. gr. 1.861
 Molecular volume, 194.

Crystalline form monosymmetric. Crystals protracted parallel to the orthodiagonal.

$$a : b : c = 1.32544 : 1 : 1.0642.$$

$$\beta = 76^{\circ} 53'.$$

Planes: ∞P ; ∞P ; $+P$; $-P$; ∞P . (C. Morton).

Ethylsulphate of Didymium, $\text{Di}_3\text{C}_2\text{H}_5\text{SO}_4 + 9\text{H}_2\text{O}$.

This compound was obtained by double decomposition of the ethylsulphate of barium and the sulphate of didymium. The salt crystallises well in large light red crystals. It loses 33.24 per cent water and alcohol at 100° .

0.4386 grm. gave 0.1861 grm. Di_2SO_4 .

In per cent—

				Calculated.	
Di_2O_3..	..	..	24.63	166	24.45
$(\text{C}_2\text{H}_5\text{SO}_3)_2\text{O}$	..	..	—	351	—
H_2O} ..	..	..	—	162	—
				679	

Specific gravity—

1.3702 grm., crystals, t° 17.8°, sp. gr. 1.860
 1.0744 " " 18° " 1.867

Mean of both determinations, 1.863.

Molecular volume, 364.5.

Crystalline form hexagonal. Optical negative, splendid crystals, protracted parallel to one of the horizontal axes of ∞P and capped by a plane of ∞P , parallel to the axis.

$$a : c = 1 : 0.50843.$$

Planes: ∞P ; ∞P ; $2P$; P ; $2P$. (C. Morton).

Specific Gravities and Molecular Volumes of the Analogous Compounds of Didymium and Samarium.

		Didymium.		Samarium.	
		Sp. gr.	M. vol.	Sp. gr.	M. vol.
R_2O_3..	..	7.179	46.2	8.347	41.7
$\text{RCl}_3 + 6\text{H}_2\text{O}$	..	2.286	155.9	2.383	153.0
ROCl	..	5.751	33.6	7.017	28.7
$\text{RBr}_3 + 6\text{H}_2\text{O}$	..	2.810	174.4	2.971	167.6
$\text{RCl}_6\text{Au} + 10\text{H}_2\text{O}$	..	2.663	274.5	2.742	269.5
$\text{RBr}_6\text{Au} + 10\text{H}_2\text{O}$	..	3.304	302.1	3.390	296.7
$\text{RCl}_7\text{Pt} + 10\frac{1}{2}\text{H}_2\text{O}$	..	2.689	288	2.712	288.5
$\text{R}_3\text{NO}_3 + 6\text{H}_2\text{O}$	..	2.249	193.9	2.375	186.9
$\text{RIO}_5 + 4\text{H}_2\text{O}$..	..	3.760	112	3.793	113.1
R_2SO_4 ..	..	3.667	156	3.898	150.8
$\text{R}_2\text{SO}_4 + 8\text{H}_2\text{O}$	..	2.829	253.1	2.930	249.6
RNH_4SO_4 ..	..	3.080	114.3	3.191	112.8
$\text{RNH}_4\text{SO}_4 + 4\text{H}_2\text{O}$	..	2.575	164.7	2.675	161.5
R_2SeO_4 ..	..	4.442	160.5	4.077	178.8
RK_2SeO_4 ..	..	3.839	121.7	4.113	115.5
RBO_3 ..	..	5.700	35.3	6.048	34.6
RP_5O_{14} ..	..	3.345	155.8	3.487	151.7
$\text{RV}_5\text{O}_{14} + 28\text{H}_2\text{O}$	..	2.494	700	2.524	698.0
R_3CHO_2..	..	3.430	80.8	3.733	76.35
$\text{R}_3\text{C}_2\text{H}_3\text{O}_2$ ..	..	2.157	150.1	2.208	148.1
$\text{R}_3\text{C}_2\text{H}_3\text{O}_2 + 4\text{H}_2\text{O}$	..	1.882	207.8	1.940	205.7
$\text{R}_3\text{C}_3\text{H}_5\text{O}_2$ ..	..	1.861	194	1.894	194.8
$\text{R}_3\text{C}_3\text{H}_5\text{O}_2 + 3\text{H}_2\text{O}$	..	1.741	238.4	1.786	237
$\text{R}_3\text{C}_2\text{H}_5\text{SO}_4 + 9\text{H}_2\text{O}$	..	1.863	364.5	1.879	365.6

From the above list it seems as a general rule that the compounds of didymium are lower in density than the compounds of samarium, but, on the other hand, the molecular volume of the didymium compounds is larger.

Still there are some exceptions. The density of the anhydrous selenate of didymium has been found higher than that of the samarium salt, an exception which I cannot explain. The molecular volumes of the chloroplatinates, the periodate, the anhydrous propionate, and ethyl-sulphate of didymium are slightly less than the volumes of the corresponding samarium salts, which I will ascribe to inexactness in the determinations or perhaps impurities.

Researches on Hypophosphoric Acid.—A. Joly.—The study of hypoarsenic acid has led the author to examine hypophosphoric acid, the composition of which he gives as $\text{PO}_4, 2\text{H}_2\text{O}$. Concerning this acid, which Dulong regarded as a mixture of phosphorus and phosphoric acids, he confirms the results of Salzer. This chemist described five sodium salts of this acid, the most important of which are the disodic and the sesquisodic. The former reacts like a free alkali upon phenol-phthaleine; the dilute solution of the second is coloured a pale violet by this reagent.—*Comptes Rendus*, Vol. ci., No. 21.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 3, 1885.

Dr. HUGO MÜLLER, F.R.S., President, in the Chair.

THE following were formally admitted Fellows of the Society:—Messrs. Herbert C. Lea, Arthur Winstone, Ernest W. Wiltshire.

Certificates were read for the first time in favour of Messrs. Peter MacEwan, 36, York Place, Edinburgh; Andrew Henderson, 29, Merchiston Park, Edinburgh; William Lang, jun., Cross Park, Partick, N.B.; Arthur Pillans Laurie, Nairne Lodge, Duddingstone, N.B.; Walter Newton, Park Green, Macclesfield; Francis Napier Sutton, 150, Loughboro' Road, S.W.; Claude Metford Thompson, University College, Cardiff; Julius Wertheimer, Oxford Terrace, St. Helens, Lancashire.

The following were elected Fellows of the Society:—Messrs. Richard Haliburton Adie; John Sabin Adriance, M.A.; Charles Morton Aikman; James Anderson; Edward Brown Clark; Malcolm J. R. Dunstan; George E. R. Ellis; James Epps, jun.; Lazarus Fletcher; William L. Gadd; Gilbert Prout Girdwood; William H. Greene, M.D.; Ernest William Harvey; George Hirst; Thomas Holgate; Matthew Hunter, B.A.; George H. Hurst; John Cecil Husband; Lewis Gordon Paul, Ph.D.; Leonard Peckitt; Charles Ranken; Luther R. Scammell; James Sim; Henry J. Staples; Stephen Stephenson; Henry Stoker; Edward E. H. Thorn; Thomas B. Tyson; Henry Collins Williams; Charles Francis Young.

The following papers were read:—

75. "On the Presence of 'Raffinose' in Barley." By C. O'SULLIVAN, F.R.S.

If the alcoholic extract of barley be evaporated and the syrup dissolved in the least possible quantity of alcohol, and a little ether added, crystals are obtained which after re-crystallisation form flattened rhombic prisms terminated by a dome parallel to the shorter axis.

The composition of these crystals is represented by the formula $C_{18}H_{32}O_{16} \cdot 5H_2O$. They melt in a little water, but are not very soluble in strong alcohol. The substance does not reduce an alkaline cupric solution. The optical activity of the anhydrous body is $[\alpha]_D^{20} = +135$; it is slowly inverted by invertase, but rapidly by a 1 per cent solution of sulphuric acid; the product of inversion readily reduces an alkaline cupric solution. It is fermented by ordinary yeast. With nitric acid it yields mucic, oxalic, and saccharic acids.

76. "On the Sugars of some of the Cereals and of Germinated Grain." By C. O'SULLIVAN, F.R.S.

Barley and wheat are proved to contain sucrose and other non-reducing and reducing fermentable sugars, the nature of which was not accurately determined. Germinated barley contains an increased quantity of sucrose, also maltose, dextrose, and lævulose. The following table is given to show the change that takes place during germination, the results being calculated in percentages on the dry matter of the body, the yield of dry malt from dry barley being known:—

	No. 1 Barley.		No. 2 Barley.	
	Before Germination.	After Germination.	Before Germination.	After Germination.
Sucrose ..	0.9	4.5	1.39	4.5
Maltose ..	{	1.2	{	1.98
Dextrose ..		3.1		1.57
Lævulose ..		0.2		0.71

In highly malted barley the sucrose is high, or if not its place is taken by the products of its inversion. Maltose

also is high in highly malted grain, but occasionally its place is taken by dextrose.

With wheat the results are similar.

As high as 11.4 per cent sucrose, calculated on the solid matter, has been found in unfermented, unacted-upon malt-wort.

DISCUSSION.

Mr. BANISTER expressed his indebtedness to the author. From experiments made on cereals in their laboratory in 1880, he was able to confirm Mr. O'Sullivan's conclusions as to the presence of sucrose in them. The results obtained were published in the second part of the South Kensington Art Handbook on the Analysis and Adulteration of Foods, page 86. A table is there given of the quantity of sugar found in certain cereals, but as this sugar was not isolated, and only examined chemically and optically, it was said of it on page 87 of the same book, that "The saccharine body behaves like cane-sugar on being inverted with the same facility, and in not reducing a solution of copper salt." Other references are made to this sugar in different parts of the book, and as it was not crystallised out, it would not have been proper to call it cane-sugar, although it possessed all its properties. The amount of the sugar in the cereals examined was determined; the results were as follows:—

Wheat, winter sown..	2.57	per cent
Wheat, spring sown..	2.24	"
Barley, long-eared ..	1.34	"
Oats, English ..	2.36	"
Maize ..	1.94	"
Rye ..	4.30	"
Rice, Carolina ..	0.38	"

The quantity of sugar present in the rye is very remarkable, and especially so as it was found that the samples of rye examined contained no sugar having a reducing action upon copper, while in all the others there was a dextrose body present in greater or less proportion.

In 1871 they had to make a series of experiments on malt-worts and the changes wrought in them by the addition of different quantities of cane-sugar. During that inquiry evidence was obtained that there was a saccharine substance in malt possessing most of the properties of cane-sugar, and the results then recorded were worked out on the same lines as we now use for expressing copper reducing power, &c., and accord closely with the most recent observations on the subject.

Mr. O'SULLIVAN, replying to Mr. Salamon, said that the method employed by him in estimating sucrose excluded albumenoids, and his analysis therefore did not afford any information as to whether such compounds were present in amounts varying with the sucrose and maltose. Dextrin or malto-dextrin was certainly present, but in very small amount, in malted grain. He added that the peculiarities in rye were probably largely due to the fact that it was usually cut green, and therefore contained bodies which were not fully elaborated.

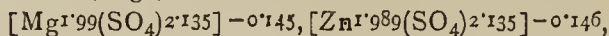
77. "Atomic Valency." By S. U. PICKERING.

The ordinary theory of atomic valency, though it may lead to many inconsistencies, must nevertheless be regarded as expressing many undeniable facts; that it is imperfect, however, must be admitted, if only on the ground that it takes no cognisance of the existence of that large class of bodies known as "molecular compounds." These cannot be satisfactorily explained, either by assuming oxygen to be a tetrad, or by the supposition of a "molecular" attraction comparable with the atomic attraction which gives rise to atomic compounds. Theoretical as well as experimental considerations indicate that the relations of the various atoms in a molecule are altered by the combination of that molecule with another to form a molecular compound; this has led the author to refer the formation of such compounds to peculiarities in the valency of the individual atoms. He considers that the number which represents the valency of any atom, though

it may very nearly approach to a whole number, is not exactly a whole number, but is slightly greater or smaller than such.

The double sulphates, which for many reasons may be considered as typical molecular compounds, consist of a sulphate, such as the alkali-metal sulphates, which do not form either hydrated or basic compounds, united with a sulphate of the magnesium or aluminium class, which form both hydrated and basic compounds. A basic salt would appear to be due to the fact that one equivalent of the metallic oxide is insufficient to saturate one equivalent of the acid; conversely, in a salt which does not form a basic salt, the acid or electro-negative portion of the normal salt will either exactly saturate, or more than saturate, the positive portion. Since in the former class of salts the excess of valency possessed by the negative portion is saturated by combination with a further quantity of the metallic oxide, these oxides must be regarded as possessing what may for brevity sake be termed an excess of positive valency. Water will be included in these metallic oxides, and will consequently act like them; a salt which forms basic salts will therefore form hydrated salts, and one which does not form basic salts will be anhydrous; this is nearly always the case.

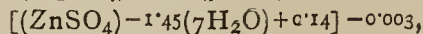
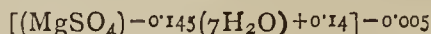
Taking the valency of H to be 1, that of O may be represented by some number slightly less than 2, say 1.98, water will then be represented as $(\text{H}_2\text{O}^{1.98}) + \cdot 02$ (using Arabic numerals to represent the valency, preceded by a sign indicating to which portion of the compound the excess of valency is due), a compound sufficiently saturated to be stable, but yet capable of further saturation, such as might be produced by its combination with any molecule exhibiting a slight excess of negative valency. The magnesian sulphates would be represented as being such bodies, *e.g.*,



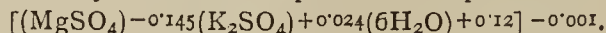
whereas a sulphate such as potassium sulphate would contain an excess of positive valency; thus—



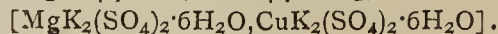
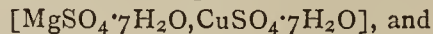
the former class would become more saturated by the addition of water,



and still more so by the displacement of one of the water molecules by a molecule of potassium sulphate—



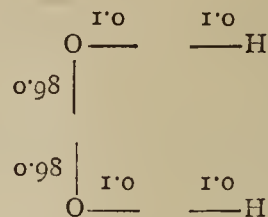
It would be possible, however, for such double salts as this, as well as for the heptahydrated magnesian sulphates, to combine with each other; but even if the residual valency in any two of these was of opposite sign it would be comparatively very small, and the double salts so formed would be much less well defined than the potassium-magnesium sulphates or the alums. An investigation of these bodies has proved that such is in reality the case; although the double salts,—



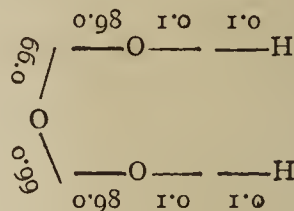
can scarcely be regarded as simple mixtures; they are certainly not definite compounds.

Lithium sulphate, being hydrated, should not form double salts, like potassium sulphate; and neither with the magnesium nor the aluminium sulphates does it produce such compounds. Sodium sulphate is undoubtedly exceptional.

The fundamental idea of this theory of unequal valencies is that each valency is to a certain extent divisible: the valency of K_2 in K_2SO_4 is represented as not only saturating that of the SO_4 in its own molecule, but of aiding the saturation of the SO_4 in another molecule, MgSO_4 . Applying this idea to atomic compounds, it will be seen that whereas water is an unsaturated compound, hydrogen dioxide may be saturated,—



the two valencies of oxygen assuming different values. This will give some explanation of the possibility of the formation of such a body, though, from the presence in it of what may be termed asymmetric oxygen atoms, its stability would not be great. H_2O_3 , however, would probably be incapable of existence, for it would not only contain asymmetric atoms, but would also be an unsaturated compound, thus—



and, as a matter of fact, neither it nor any corresponding compound of a monad metal does exist. But there would not be the same objections to the existence of H_2O_4 , for it would form a saturated compound, and, although such an oxide of hydrogen is unknown, the corresponding potassium oxide exists.

The objections to the existence of oxides of monad metals containing 3 or 5 atoms of oxygen would not apply to their sulphides, for the higher valency of sulphur would permit of such a compound as H_2S_3 being saturated; consequently we find that such sulphides do exist.

The author proceeds to show that, in some cases, a slight increase of complexity may favour stability, whereas in others it would produce the reverse effect. As instances of the former he takes Cu_2S_2 , As_4O_6 , S_2O_6 : he also shows that a metal which is in reality a tetrad may never occur in any but a pseudotriad form, as in the case of aluminium. His theory, he considers, gives also a clear conception of why the properties of one atom are affected, not only by the nature of another atom with which it is combined, but also by the nature and number of the other atoms to which this second one is united.

Finally he suggests that the peculiarities of the compounds of carbon and hydrogen may receive some explanation from such a theory. It is only necessary to imagine that the valency of hydrogen is exactly, or very nearly exactly, equivalent to each valency of carbon, and we have at once an explanation of the possibility of producing compounds of these elements far more complex than those of any other elements. If such be the case, it will follow that the hydrocarbons will show little or no tendency to form molecular or residuary compounds, and, as a matter of fact, the number of such compounds which they form is very small when compared with those of other bodies. The introduction of oxygen into a hydrocarbon will not endue it with a tendency to form a true hydrate, for the resulting body will possess an excess of positive atomicity; consequently we find that the compounds of water with an oxygenated hydrocarbon are more correctly represented as "atomic" compounds (hydrols), and that it is only on the introduction of some element other than oxygen that a substance is obtained capable of forming a true hydrate.

At the next meeting, on December 17th, there will be a ballot for the election of Fellows, and the following papers will be read:—

"The Action of Steam on Carbonic Oxide." By H. B. Dixon.

"On Multiple Sulphates." By Miss E. Aston and S. U. Pickering.

PHYSICAL SOCIETY.

November 28th, 1885.

Prof. GUTHRIE, President, in the Chair.

MR. J. H. BLAKESLEY was elected a Member of the Society.

The following communications were read:—

"On the Calibration of Galvanometers by a Constant Current." By T. MATHER.

A current is passed through the coils of a galvanometer, which may be of any form; the galvanometer is turned in a horizontal plane through any angle, which need not be recorded, and the deflection θ of the needle noted. The current is then broken, and the needle swings back, taking up its position in the magnetic meridian: the angle through which it turns to do this is also noted, δ . This is repeated with the galvanometer in various positions and with the same current, and a curve is drawn showing the relation between the values of $\frac{\sin \theta}{\sin \delta}$ and corresponding values of θ .

When the instrument is now used in its normal position, it is readily seen that a current producing a deflection θ of the needle is proportional to the value of $\frac{\sin \theta}{\sin \delta}$ corresponding to θ obtained in the calibration experiment, which may be read off at once from the curve.

"On a Machine for the Solution of Cubic Equations." By H. H. CUNYNGHAM.

This machine the author believes to be the only one hitherto constructed that gives the imaginary as well as the real roots of a cubic equation. A cubical parabola is drawn upon paper, the ordinates being the cube roots of the corresponding abscissæ. To find the roots of a cubic, first reduce it by Cardan's rule to the form $x^3 - Ax - B = 0$. Then measure off along Ox a distance equal to B , and from this point, T , draw a line making an angle equal to $\cot^{-1} A$ with Ox . The ordinates of the points where this line cuts the curve are the roots of the equation. To find the imaginary roots when they exist, first find the real root as before: from this point draw a tangent to the branch of the curve the other side of Oy ; then if this line cut the axis of x at a point Q , and a be the real root, the two imaginary roots are—

$$\frac{a}{2} \pm i \sqrt{\frac{QT}{a}}$$

Instead of actually going through the construction as above, the operation is preferably performed by applying a protractor with a tangent scale to the curve with its centre at T , setting it, and reading off the point of the curve cut by its edge.

"On a Machine for the Solution of Equations." By C. V. BOYS.

After mentioning Mr. Hinton's apparatus, lately shown to the Society, and briefly describing Mr. Kempe's equation machine, Mr. Boys explained a machine he had constructed, consisting of a system of beams, each provided with a pair of pans, and working upon a fulcrum at the middle. The pans of the first beam are marked $+a$ and $-a$, those of the second $-b$ and $+b$, the next $+c$ and $-c$, and so on. Into these, weights equal in value to the coefficients a, b, c , &c., of an equation $a + bx + cx^2 + \dots = 0$ are to be placed. A sliding joint is arranged to connect a point opposite the positive pan of each beam with a rib at the back of the next lower one. Alternate beams are placed opposite one another, and each set can be slid past the other, the peculiar connecting joints being able to slide past the fulcra and the pans on each beam. To solve an equation, the coefficient weights are placed in their pans, and the two sets of beams are made to slide past one another. At certain positions the beams change the direction of inclination. These positions of balance are noted on a scale, the readings of which are roots of

the equation. When there are not more than two impossible roots the machine will find them: for this purpose the real roots are first found and divided out, the resulting quadratic being placed on the machine. Instead of a change of inclination of the beam, a maximum or minimum of pressure is observed by a spring balance. The reading of the scale is then the real part of the root, and the square root of the pressure the impossible part.

Mr. A. HILGER exhibited and described a New Driving Clockwork of isochronous motion regulated by a fan-governor, and a New Direct-Vision Spectroscope.

OBITUARY.

MR. E. O. BROWN.

It is with deep regret that we have to announce the death of Mr. E. O. Brown, which took place very suddenly on Saturday evening last. Mr. Brown was one of the chemists in the Royal Arsenal, Woolwich, under Sir F. Abel. Of late years his attention had been chiefly directed to explosives. His knowledge of the chemistry of these unstable bodies was perhaps unsurpassed, and his death will leave a blank not easily filled. Personally, the writer has lost in Mr. Brown one of his oldest friends,—a friend whose judgment and advice he could always rely on, whose accurate insight into obscure chemical problems he could always trust, and whose amiability of disposition was such that he cannot recall a single occasion on which the firm friendship, dating from thirty-five years ago, has been overcast by a shadow of misunderstanding.

CORRESPONDENCE.

THE HELL-GATE EXPLOSION NEAR NEW YORK,
AND SO-CALLED "RACKAROCK."

To the Editor of the Chemical News.

SIR,—I have read attentively Mr. Divine's letter and caveat in the CHEMICAL NEWS (vol. lii., page 271). In reply I beg to say that if I have erroneously considered myself "to be the discoverer of that class of explosive compounds" spoken of in this caveat I have the satisfaction of knowing that during the last 14 years everyone else (except Mr. Divine and his notary) has fallen into the same error, owing to the fact that we had no knowledge of the existence of a second claimant.

Mr. Divine seems to overlook the all-important point, that a caveat is not a publication: a caveat is a secret deposit, entrusted in this instance to the keeping of the "confidential" archives of the U.S. Patent Office, where it seems to have been faithfully kept, and that to Mr. Divine's own satisfaction, for he says of me: "I do not doubt that he made his invention without knowledge of what I had done."

Precisely so. The public (including myself) was unacquainted with Mr. Divine's doings prior to December 7th, 1880—the date of his first patent.

Now, after the lapse of 14 years 10 months and 20 days, this caveat is unearthed and published for the first time in London November 27th, 1885. I am inclined to think that such a hidden document cannot take the place and rank of my publication of April 6th, 1871; nor do I see how a patent can fitly be granted a second time to someone else for the identical invention which I patented 9 years 8 months and 1 day previously.

That the same find may be made simultaneously by different investigators has been often enough recorded in the pages of the history of inventions; and in such cases it is the custom, if I am not mistaken, to consider him as the dis-

coverer who first *dis*-covers his find to public view, not him who covers it up and hides it—be this in the confidential archives of his own heart or in those of the U.S. Patent Office.

Sympathising with Mr. Divine in the disappointment he must feel at having *dis*-covered his find too late by 9 years 8 months and 2 days, I avail myself of this opportunity to express my appreciation of his and his associates' recent energy and enterprise, which have raised this subject to its present position, culminating in the memorable explosion of the Hell-Gate mine.—I am, &c.,

H. SPRENGEL.

Savile Club, 107, Piccadilly,
London, Dec. 6, 1885.

LONDON WATER SUPPLY.

To the Editor of the Chemical News.

SIR,—From various passages in some of your contemporaries we gather that the report on the examination of the Metropolitan Water Supply by means of the Gelatin method, as published in the Water Examiner's report for October, has been much misunderstood, and that some explanation of the scope and meaning of this method of examination is desirable.

We have had recourse to this method of examination in order to detect the organised matter present in the London Water Supply; it must not, however, be supposed that this living matter is necessarily either the result of sewage contamination or prejudicial to health. On the other hand, it is obviously desirable to have water for domestic use as free from all living organic matter as possible, and inasmuch as the processes of subsidence and filtration, to which the water is subjected before delivery to the consumer, have for one of their objects at least, the removal of such matter, it is of importance to ascertain whether, and to what extent, these processes of purification are efficient.

The results obtained for the months of September and October by the Gelatin method, and published for the first time in the October report, show that whilst the Thames Water at the intakes of the Companies contained upwards of 1000 organisms, the average number found in the samples taken from the main amounted to 28. This result speaks for itself as to the efficiency of the Companies' treatment of the *raw material* with which they have to deal.

Any public alarm which the misapprehension of our reports may have caused will doubtless be allayed by a consideration of the fact that micro-organisms are not only present in nearly all natural waters, but that they are inhaled by every inspiration from the air. This being so, it is eminently satisfactory to find that the water supplied to London contains so small a quantity of organised matter, and that filtration has such a power of removing these micro-organisms.

PERCY F. FRANKLAND:
FRANCIS BOLTON.

4, The Sanctuary, S.W.
Dec. 3, 1885.

Referring to the same subject, the following letter has been sent to the secretaries of all the London Water Companies:—

"Sir,—The examination of water for micro-organisms and the indications afforded by their presence have been occupying our attention for some months past. Seeing that we propose in a short time to deal with the subject in detail, it seems better for the moment we make no other remark than this, that the attempt from the biological standpoint to condemn London water will, in our judgment, be as conspicuous a failure (even if, indeed, it be not a more conspicuous failure) as the attempt to condemn it from the chemical standpoint of organic carbon and

nitrogen. The one having broken down some new creation was, it seems, necessary.

"We are fully alive to the importance of the new attempts, and you may rest assured that in your interest it will be met in due course.—We are sir, your obedient servants,

"WILLIAM CROOKES,
"WILLIAM ODLING,
"C. MEYMOTT TIDY.

"December, 1885."

THE INSTITUTE OF CHEMISTRY.

"EVIDENCE OF FITNESS" *v.* EXAMINATION.

To the Editor of the Chemical News.

SIR,—I am decidedly of opinion that it should be *optional* with the council to admit Fellows on *evidence of fitness*. The only question is the nature of the evidence. It is clear that this term may apply to the result of an examination, but it does not follow that the candidate should be compelled to attend at a certain place to be examined. Surely questions might be sent him which would test his knowledge, and which he could not answer by mere reference to books! Or he might be required to write an original thesis, as is the custom at D.Sc. examinations. At the same time testimonials from his teachers or employers should be forthcoming.

In cases where the "evidence" is not completely satisfactory I should certainly insist upon an examination by a competent examiner at some local centre.

In your last issue "J." complains that he "cannot find time for any *preparation* for examination." I should have imagined that a candidate who is able to "prove his ability" could pass the required examination without any preparation at all.—I am, &c.,

F.I.C., F.C.S.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—Regarding the apparently well-founded rumour that the Council of the Institute propose, at least for a time, to suspend the entrance examination and admit persons on mere evidence of fitness, I am inclined to think that such a course would be most prejudicial. For, at the outset, between the years 1877-1880 the doors of the Institute were opened sufficiently wide and long to admit all well-known professors and lecturers at the more important educational centres, manufacturers, analysts, and private individuals engaged in research. A few persons included within the category were either opposed to the scheme, or did not at the time foresee any advantages to be gained; these, together with a few others who have really distinguished themselves in the interim, might be offered admission to the Institute. The names of twenty such persons at the most would readily occur to the Council. But the admission of a number, possibly of a baser sort, would be totally at variance with the regulations laid down by the council, the recent address by Prof. Odling, and the whole spirit of the Institute. For if the corporation is to fulfil towards the profession of chemistry a function similar to that of the Incorporated Law Society for solicitors, the Inns of Court for barristers, and the Colleges of Surgeons and Physicians for the medical profession, then its entrance examination should include not only the science and practice of chemistry and allied branches of knowledge, but also the elements of a general education. Of the latter, some calling themselves chemists are, to judge from their writings, profoundly ignorant. For admission into any of the above-named corporations the mere serving of articles or the authorship of some paper on a legal or medical point is not of itself sufficient.

Exclusiveness is the only *raison d'être* for the Institute

as it exists side by side with the Chemical Society and the Society of Chemical Industry. —I am, &c.,

V.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—If the rumour mentioned by F.I.C. (CHEMICAL NEWS, vol. lii., p. 272) is true, it indicates that the Council of the Institute of Chemistry have found that their present regulations are unsatisfactory, and they are to be congratulated on the wisdom of the proposed change.

The putting of an examination as the *sine qua non* of admission to the Institute must be seen by all, except those who are enamoured of our examination system, to be an utter absurdity. Practical chemistry of all subjects lends itself least readily to examination. Take a chemist, place him in a strange laboratory with the arrangements of which he is quite unfamiliar, give him an analysis to do in a limited time, under the eyes of an examiner, and on the results (that is, probably, on how near the results come to those obtained by someone else previously) decide whether or no he is a qualified chemist. The whole is too absurd; the wonder is that the system has been allowed to go on so long.

If the examination policy is persevered in, it means one thing: that no chemist will enter the Institute, for certainly no one who respects himself will submit to have his qualifications decided by such a test, conducted probably by men of no higher standing or larger experience as chemists than himself, and hence the Institute will be altogether recruited from the ranks of students and laboratory assistants.

It cannot be held that examination is necessary to raise or to keep up the status of the Institute, for of all societies the one most valued and respected is probably the Institute of Civil Engineers, and that has never yet instituted an entrance examination; and if the Institute of Chemistry would take the same ground, insist on evidence of training and fitness, and abolish the absurd examinations, it would do more for chemistry than it can do under the present system. We look to our leaders to help us to stem the examination torrent, but instead of so doing they, too, seem to have been swept away by it.

In conclusion, if the Institute is become what it aims at being, and is to embrace all chemists within it, it must do more than it has done in the past to show that it is something more than an association for collecting subscriptions.—I am, &c.,

A. H. S.

Glasgow, Dec. 7, 1885.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 21, November 23, 1885.

Application of Cryoscopy to the Determination of Molecular Weights.—F. M. Raoult.—The molecular lowering of the congelation, T , of a dissolved substance is obtained, as it is known, by multiplying the molecular weight, M , of this substance by its coefficient of lowering,

A , in the solvent employed. We have then $M = \frac{T}{A}$. The coefficient of the lowering of the congelation-point is obtained in each particular case by dividing the lowering of the congelation-point by the weight of the substance which exists in solution in 100 grms. of the solvent. The molecular lowering, T , is a quantity which varies from

one solvent to another, but which, in one and the same solvent, remains the same for numerous well-defined groups of compounds, and may be considered as known, at least approximately. Hence it follows that the approximate value of the molecular weight, M , of a dissolved substance may be calculated by means of the foregoing formula, and may serve to determine the choice between two molecular weights which are multiples the one of the other. Experiments made on more than 250 compounds of all kinds prove that correct results may thus be obtained.

Combustion-Heat of Certain Substances of the Fatty Series.—M. Louguinine.—A thermo-chemical paper not capable of useful abstraction.

A New Method of Chloridation.—Albert Colson and H. Gautier.—The authors have established that phosphorus perchloride renders it possible to introduce a determinate quantity of chlorine into the homologues of benzene; and that the chlorine liberated by phosphorus perchloride acts upon the benzenic hydrogen only after having been substituted for the hydrogen of the lateral chains.

Presence of Methylic Alcohol in the Products of the Distillation of Plants with Water.—M. Maquenne.—Water which has been distilled over fresh plants contains methylic alcohol, sometimes in considerable proportions. In the nettle it reaches to about 3 parts to 1000 parts of the plant calculated in the dry state. As to its origin, two hypotheses are admissible; either the methylic alcohol exists as such in the plants and distillation merely conveys it away, or it is generated during the distillation at the expense of some more complex proximate principle.

Bulletin de la Société Chimique de Paris.

Vol. xlv., No. 8, Nov. 5, 1885.

Purification of Sulphuric Acid and Preparation of Nitric Acid.—Prof. Kupferschläger.—All chemists know that commercial sulphuric acid, prepared from iron pyrites, contains lead and calcium sulphates, nitrous and sulphurous vapours, arsenic acid, sometimes selenious acid, thallium sulphate, and hydrogen fluoride. For its purification the author dilutes it with its own weight of water, then passes through it in excess a current of washed sulphurous acid, so as to bring the arsenic and nitric acids to a lower stage of oxidation, and to reduce selenious acid if present. A current of hydrogen sulphide is then passed through it twice, with an interval, each time as long as it is absorbed. The vessel is then closed, and allowed to stand for some time at a moderate temperature, so that the lead and arsenic sulphides, selenium, &c., may subside. The sulphuric acid is then rectified in glass retorts, applying the heat so as to reach the upper portion only.

MISCELLANEOUS.

University College, Liverpool.—Sheridan Muspratt Chemical Scholarship.—The College will offer for competition the Sheridan Muspratt Chemical Scholarship, the examination for which will commence on December 14th, and continue on the following days. The Scholarship is offered under the following regulations:—The Scholarship shall be of the annual value of £50, tenable for two years. In awarding the Scholarship strong preference will be given to students under 23 years of age on January 1st, 1886, though under exceptional circumstances candidates above that age will be permitted to compete, provided they have first submitted to the Senate of the College an account of their previous studies, and a full statement of their objects in competing for the Scholarship, showing a sufficient cause for the relaxation of the restriction as to age. The Scholarship will be awarded mainly upon knowledge of Chemistry, the subjects of examination being—The Principles of Chemistry; Chemistry of the Metals and Non-Metals; Elements of Organic Chemistry; Quali-

tative Analysis and General Laboratory Work; Simple Quantitative Analysis. The examination in these subjects will extend over three days, one at least of which will be devoted to practical work in the laboratory. Candidates who have not taken a University degree will further be required to satisfy the examiners in—(1) Physics, especially Heat and Electricity; (2) Mathematics, especially Algebra up to Binomial Theorem and Logarithms; (3) English Essay; (4) One of the following languages—Latin, Greek, French, German, Italian. (For purposes of chemical study candidates are recommended to prepare themselves in German in preference to other languages.) The successful candidate will be required—(1) To work systematically in the College laboratories; (2) To attend College Classes in the higher branches of Chemistry; (3) Either to proceed to a University degree in Science—of which Chemistry forms a principal feature—or to occupy the whole or the greater part of his time in chemical research conducted in the College laboratories under the direction of the Professor of Chemistry, and to the satisfaction of the Senate. The holder of the Scholarship will be required to present a half-yearly report, which shall include a statement, upon the progress of any branch of chemical research which he may be undertaking; and this report shall be submitted to the Senate by the Professor of Chemistry, with such remarks as he may think fit. A satisfactory report will be regarded as a condition of the Scholar continuing to hold his Scholarship. In the event of no candidate of sufficient merit competing for the Scholarship, the Senate shall be at liberty to withhold the Scholarship, and to make provision for a new examination at such time as may seem expedient, and any income arising from the Scholarship being permitted to remain vacant for a term shall be applied in promoting the study of Chemistry by way of prizes, exhibitions, entrance scholarships, or otherwise, as the Council shall determine.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Soap.—(Reply to "Importer.")—Soap is soluble in water and in alcohol. Chalk and talc are not soluble.—A. P. S.

Turpentine.—(Reply to "Reader.")—Consult Dragendorff, *Pharm. Journal*, vol. vi. There is no thoroughly reliable test.—A. P. S.

Oil of Rhodium.—Can any of your readers inform me what is meant by "Oil of Rhodium." It is said to have great soothing powers on horses. I cannot find an account of it anywhere?—NORMAL CYANIDE, F.C.S.

TO CORRESPONDENTS.

F. H. T. A.—Any large London dealer in stoves will, we understand, procure German heating stoves to order.

MEETINGS FOR THE WEEK.

- MONDAY, 14th.—Medical, 8.30.
 — London Institution, 5.
 — Society of Arts, 8. (Cantor Lectures,) "The Microscope," by John Mayall, Jun.
 TUESDAY, 15th.—Institution of Civil Engineers, 8.
 — Pathological, 8.30.
 WEDNESDAY, 16th.—Society of Arts, 8. "Burmah, Present and Future," by Holt S. Hallett.
 — Meteorological, 7.
 — Geological, 8.
 THURSDAY, 17th.—Royal, 4.30.
 — London Institution, 7.
 — Philosophical Club, 6.30.
 — Chemical, 8. "The Action of Steam on Carbonic Oxide," by H. B. Dixon. "On Multiple Sulphates," by Miss E. Aston and S. U. Pickering,

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THE CHEMICAL NEWS.

VOL. LII. No. 1360.

SCIENCE IN THE LAW-COURTS.

"While the position of Science is universally recognised, the position of the scientific man is not."

MOST of our readers will have taken into consideration the Address delivered by Dr. Odling at the recent meeting of the Institute of Chemistry. Undoubtedly the speaker laid down certain propositions concerning which difference of opinion prevails, and which may give scope to candid and not unfriendly discussion. But it was with the utmost surprise that we read the lengthy critique on the above address which appeared in *Nature* for November 26th. What may have been the esoteric motives of the writer we have not space to enquire; but we cannot help perceiving that, whilst entirely passing over the most debatable points in Dr. Odling's speech, he introduces much matter for which there is very little of either occasion or justification.

Passing to our more immediate subject, we find *Nature* at any rate admitting that, "since experts there must be," our present manner of obtaining scientific evidence is most unsatisfactory. Herein, at least, our contemporary has our full concurrence. He writes:—"The appearance of a man of Science, occupying a 'leading position' as an expert in a Court of Law, whose 'devotion' to his employer causes him to apparently contradict the statements of another man of Science on the other side, doubtless equally 'devoted,' does not add to his dignity. A well-known lawyer, now a judge, once grouped witnesses into three classes—simple liars, damned liars, and experts. He did not mean that the expert uttered things which he knew to be untrue, but that by the emphasis which he laid on certain statements, and by what has been defined as a highly cultivated faculty of evasion, the effect was worse than if he had."

We find next an enumeration of the qualities which an expert must have. "Coolness under cross-examination, verbal dexterity, a ready wit, . . . the fidelity of a partisan, and a dash of impudence." We freely own that if a scientific witness does not possess these attributes, then, whatever his knowledge, he will suffer more or less humiliation and loss of prestige. From such unpleasant result no determination on his part to tell "the truth, the whole truth, and nothing but the truth," will in the least avail to save him. He will not unfrequently be regarded as a partisan, prepared to lie for a fee, and he will be treated accordingly.

Let us now look at this question as it presents itself to men of science, alike to the chemist, the physicist, the mechanician, the geologist, the physician, and the microscopist, though certainly not to the astronomer, who is in no danger of being called, as such, to give his testimony. The expert occupies a totally anomalous position in court. Technically he is a mere witness; practically he is something between a witness and an advocate, sharing the responsibilities of both, but without the privileges of the latter. He has to instruct counsel before the trial and to prompt him during its course. But in cross-examination he is the more open to insult because the court does not see clearly how he arrives at his conclusions, and suspects whatever it does not understand. The late Dr. R. Angus Smith complained of being "contemptuously compelled to herd with thieves and scoundrels in a witness-box." He adds:—"I have seen barristers speaking to a scientific witness in such a way as to show that to them a witness was always an inferior person." Surely every person who has been present at a technical trial, or has had to appear

as an expert in a poisoning, a patent, or an adulteration case, will be able to confirm this from his own observation and experience.

Now it may, perhaps, be cynically hinted that men of science should be willing to bear all this annoyance for the public good. But is it for the public good? In the first place, not a few of the most eminent men in every department of science distinctly and peremptorily refuse to be mixed up in any affair which may expose them to cross-examination. "I will investigate the matter, if you wish it, and will give you a report for your guidance, but only on the distinct understanding that I am not to enter the witness-box." Such in substance is the decision of not a few men of the highest reputation and the most sterling integrity. Certainly it is not for the interests of justice to render it impossible for such men to give the court the benefit of their knowledge.

Further, the spectacle of two men of standing contradicting or seeming to contradict each other in the interest of their respective clients is a grave scandal. Men of the world are tempted to say that "Science can lay but little claim to certainty, and is rather a mass of doubtful speculations than a body of demonstrable truth." To us, at least, there is nothing more saddening than to read the trial of a notorious poisoner, or the report of a great patent case, especially if taken along with the comments of the press and of society on these occasions.

Here, then, we see that our present mode of dealing with scientific evidence is found on all hands unsatisfactory. The outside public is scandalised; experts are indignant; the bench and the bar share this feeling, but unfortunately are disposed to blame the individual rather than condemn the system.

But we fear that this unanimity of dissatisfaction will vanish as soon as a remedy is seriously proposed. To that however, we must come unless we are willing to dispense with scientific evidence altogether.

As it seems to us, the expert should be the adviser of the court, no longer acting in the interest of either party. Above all things he must be exempt from cross-examination. His evidence, or rather his conclusions, should be given in writing and accepted just as are the decisions of the bench on points of law.

Here for the present we must invite the suggestions of our readers, hoping to arrive at some definite result from their collective wisdom.

ON THE FLUORESCENCE OF THE RARE EARTHS.

By M. LECOQ DE BOISBAUDRAN.

THE following are the four principal objections which the observed facts suggest in opposition to my theory:—

1st. Relating to the mutual extinction of my earths A and B (sulphates *in vacuo*): yttria being the essential cause of fluorescence, is there in B an earth which opposes the fluorescent vibration of Yt_2O_3 ?

2nd. But as B gives a distinct fluorescence by my process of reversion, the spectra obtained by the two methods are perhaps not due to the same substances. Yttria fluoresces *in vacuo* as sulphate, and not in solution; the contrary takes place with $Z\alpha$ and $Z\beta$: these are inert in the solid state, but fluoresce in solution. This hypothesis rests partly on the difference of constitution of the bands obtained by the two methods.

3rd. Yttria, the real cause of fluorescence, does not vibrate alone. Does the presence of one or more oxides of the terbium group give it the property of fluorescing *in vacuo*, as lime does with Sm? This hypothesis is not incompatible with the first, for the earths of the terbium group might contain some bodies favourable to the fluorescence of yttria, and others with the opposite effect.

4th. Even with my process of reversion one of the earths of the terbium group weakens the citron band especially, while another affects the green band instead. This would explain the difference of brilliancy of these two bands that I have noticed in several preparations. The bands 105, 115, &c., belonging to yttria would be unequally modified by foreign substances.

Answers to the Preceding Objections.

First objection.—This might apply to the fluorescence of sulphates *in vacuo*, but not to that of solutions tested by reversion, as the following experiment shows:—

I mixed equal quantities of my earths A and B; the hydrochloric solution gave the same fluorescence as with B only, except diminishing sensibly the brilliancy in proportion to the extent of the dilution of B. It seems to me to result from that, that if A alone does not fluoresce by reversion it is not because it contains a substance which stops yttria—of which it is almost entirely composed—from vibrating; if such were the case the fluorescence of B would have been extinguished or very much diminished. If B, very poor in yttria, gives by itself a distinct fluorescence, it is certainly not because it contains an earth facilitating the vibration of yttria (3rd objection), since the addition of A does not increase the fluorescence of B. Thus A and B retain their respective fluorescences in the mixture. The 1st and 3rd objections do not apply, therefore, to the fluorescence of solutions. The independence between the different earths ought, on the other hand, to be much greater in a liquid than in a solid. I have never noticed any change in the constitution of the bands of reversion obtained from widely differing substances, while Mr. Crookes has noticed numerous consecutive modifications by the addition of lime, oxide of lead, &c., to the earth examined by his method.

A large proportion of CaCl_2 does not modify the fluorescence of my earth A in hydrochloric solution. This fact has also been observed by Mr. Crookes.

I have obtained fluorescence of the bands of $Z\alpha$ and $Z\beta$ with a very acid nitric solution.

A mixture of Sm and of the earths of the terbium group (with or without Di), dissolved in HCl, gives by reversion the bands of Sm and those of $Z\alpha$ and $Z\beta$ all at once. There is no mutual extinction, as is the case in Mr. Crookes's fine experiment (sulphates *in vacuo*).

Second objection.—If we admit that the bands obtained by the two methods are of identical origin, the question would be decided in my favour; but these bands are not the same, not being formed of the same elementary lines and their positions varying a little. Anyhow the following reasons militate in favour of common origin. Sm is an example of bands undergoing changes of the same kind, according to the method of observation and the nature of the substance added, as Mr. Crookes has shown in a striking manner.

It would be very surprising if bodies so essentially different were to give a similar series of bands, whose general appearance was so analogous, placed relatively in the same manner, and only differing in details, like the spectra of solid mixtures of Di differ among themselves.

Third objection.—Answered with the first.

† *Fourth objection.*—The independence of the fluorescences in mixtures of earths examined by reversion partially answers this objection. In a fluorescent spectrum a given band might, however, be hidden, to the exclusion of others, either by an absorption band of liquid (a case easy to conceive*), or because certain exciting rays of fluorescence might be absorbed in another part of the spectrum. According to M. Becquerel the extinction of our fluorescence would therefore commence very probably at a certain point and stretch more or less towards the red; at the most it would produce an extinction or a pretty large space limited on the right and left. But the relative variations of $Z\alpha$

and $Z\beta$ would only be explained thus by admitting a very local extinction of the position of the band $Z\alpha$ 104.9 (about λ 580.6 to λ 565.8), and stretching neither to $Z\beta$ 115.2 (about λ 553.4 to λ 538.5), nor to 101 (about λ 590.9 to λ 580.6), which touches $Z\alpha$. This is perhaps not theoretically impossible, but it seems to me very improbable.

The following observations bear on the present discussion:—

One of my earths does not give any trace of the yttria spectrum by the direct spark, and it occupies, in the fractionation to which it belongs, a place some distance from the point where yttria commences to show itself: this earth gives by reversion a very beautiful fluorescence, $Z\alpha$ 105 stretching to $Z\beta$ 115.

Another earth shows no yttria in the spectroscopy, and gives by reversion a magnificent fluorescence, comprising the bands $Z\beta$ 115 and others, all very strong; while $Z\alpha$ 105 is comparatively undeveloped.

To sum up: I believe that yttria is not the first cause of the bands $Z\alpha$ 105, $Z\beta$ 115, &c., obtained either by Mr. Crookes's method or by mine. The proof will be found if the spectra observed by the two methods could be shown to be rigorously identical. In support of my opinion I would remark that the purest yttria gives the most feeble fluorescence, not only in solution of reversion, but also *in vacuo* as sulphate.

Leaving my earth A, I have prepared yttria (without doubt the purest yet obtained) whose sulphate only gives a slight trace of $Z\alpha$, $Z\beta$, &c., *in vacuo*,* belonging to the fluorescence which occupies us, and which is so brilliant with my earth A, Mr. Crookes's earth B, and M. Clève's yttria. The addition of 3 to 6 parts of lime to my new yttria does not develop the bands $Z\alpha$, $Z\beta$, &c.; it even makes them almost imperceptible. I hope to be able to completely eliminate the traces of foreign matter, which I believe cause this residue of fluorescence of my earth A.†

As in purifying yttria we see the fluorescence belonging to the old yttria disappear, we notice the apparition of a new, very different, fluorescence‡ that I have been studying for some days, and of which I describe the principal characteristics in a sealed packet which I have the honour of placing on the table with the present note.—*Comptes Rendus*, Sept. 14, 1885.

CLARK'S PROCESS FOR PURIFYING WATER.

By RICHARD P. PROSSER.

ALL the chemical text-books with which I am acquainted attribute the invention of the method of softening water by lime to Prof. Clark, of Marischal College, Aberdeen. His patent was taken out in 1841, and the specification is for the most part devoted to an explanation of his well-known soap-test. There is no formal "claim," but the invention is described at the outset as consisting in "a mode of rendering certain waters less impure and less hard by the application of lime *in certain proportions as hereinafter explained*. It has occurred to me, for reasons which I shall presently give, that Clark was not the inventor of the method of softening water with which his name is associated, and that he did not intend to make a general claim to the use of lime for neutralising the excess of carbonic acid in water holding carbonate of lime in solution, but only to a particular method of ascertaining the quantity of lime necessary to effect such neutralisation.

In the year 1838, three years before Clark's patent, a patent was granted to John Melville, who is described as

* $Z\alpha$ 105 only is distinctly visible, although very feeble.

† This will perhaps be difficult with the substance in my possession because of the extreme diminution in quantity caused by the numerous operations which have been necessary to prepare it.

‡ This fluorescence is of a beautiful rose-colour.

* This case presents itself for the band $Z\alpha$ 105, when the liquid contains a notable quantity of Di,

of "Upper Harley Street, in the county of Middlesex, Esquire," for various improvements in the generation of steam. The following passage occurs in his Specification:—"Secondly, as to my improvements by chemical process. Having found by experiment that carbonic acid existing in a free state is one cause of the earthy salts adhering to the interior surfaces of boilers, to prevent this adhesion I saturate the free carbonic acid either with lime-water, or with other substances capable of neutralising carbonic acid, or with lime put into the water before the water is introduced into the boiler or generator. The saturation of carbonic acid with lime-water and other similar neutralising substances is well known, but I only claim as my invention the application of this chemical process to boilers, for the purpose of preventing incrustation. I prefer lime because it is the cheapest article."

In spite of the ambiguity of the language I think it must be admitted that Melville was perfectly acquainted with the softening effect of lime upon water containing carbonate of lime retained in solution by excess of carbonic acid. The wording of the last sentence but one in the above extract, coupled as it is with a limited claim to the special application of the process to boiler feed-water, would almost lead one to think that he did not regard himself as the actual inventor of the method. The words "the saturation of carbonic acid with lime-water and other similar neutralising substances," &c., are, however, in all probability, nothing more than the mere expression of a well-ascertained chemical principle.

Although it is unconnected with the immediate subject of my letter, I may here draw attention to the fact that MM. Boutron and Boudet received a medal from the Paris Academy of Sciences, in the year 1855, for a process of purifying water in no way distinguishable from that proposed by Prof. Clark.

ON THE ACTION OF ZINC DUST ON ZINCIC HYDRATE.*

By GREVILLE WILLIAMS, F.R.S.

IN the course of an investigation on "The Action of some Heated Substances on the Organic Sulphides in Coal Gas,"† I found that when unpurified gas containing cyanides was passed over fragments of palladium pumice (or, as I have generally called it, "palladised pumice") an alkaloid was formed. The quantity was, however, so small that I sought for a substance which could be used on a larger scale than was convenient with palladium, and in an article "On the Synthesis of Trimethylamine and Pyrrol from Coal Gas, and on the Occlusion of Hydrogen by Zinc Dust,"‡ I showed that, under certain conditions, zinc dust behaved towards hydrogen like palladium. As the heated zinc dust gradually lost its effect, and, like the palladised pumice, had its power restored by passing hydrogen or coal gas containing hydrogen over it in the cold, I inferred that the zinc dust occluded hydrogen at ordinary temperatures, and gave it off in an active condition when heated. In another article, "Note on the Occlusion of Hydrogen by Zinc Dust and the Meteoric Iron of Lenarto,"§ I showed that the specimen of commercial zinc dust with which I was then working gave off, when heated, about 40 times its volume of hydrogen; and I threw out the suggestion that the gas had been originally derived from water. In another article, "On the Source of the Hydrogen occluded by Zinc Dust,"|| I showed that when the dust was exposed to the vapour of water at ordinary temperatures for a long time, and, after drying at 100° C., was heated to redness, it gave off no less than

362 times its volume of hydrogen. I also showed that zinc dust slowly absorbs moist hydrogen at ordinary temperatures.

My duties taking up almost the whole of my time, I have only been able to work in a very fragmentary manner; and, although my experiments have always hitherto appeared to confirm the ideas which induced me to make them, I have felt for some time past that the hydrogen probably existed in the dust in two conditions, and that *all* the hydrogen given off on heating had not been occluded in the sense understood by Graham. I felt bound, therefore, to ascertain whether the large amount of 362 volumes was not more or less due to a reaction of the zinc dust upon the hydrate of the metal. The results which I have obtained convince me that the investigation is likely to be a long one, and will have to be extended to other metals. I find, amongst other things, that zinc dust which has been exposed to a damp atmosphere gives off much of the hydrogen present below the temperature of the melting-point of lead. I also find that finely-powdered iron, after exposure to damp, gives off hydrogen when heated. But what I especially desire to call attention to in this note is the reaction which takes place between zinc dust and hydrate of zinc. I dissolved in hydrochloric acid some of the so-called pure zinc sold for the detection of arsenic, precipitated it with ammonia, and washed the product for two days. It still, however, retained some chlorine. The precipitate was dried in the water oven, and then mixed with an equal weight of a sample of commercial zinc dust, which, on heating alone, gave off about fifty times its volume of hydrogen. The mixture on being heated to redness gave off in one experiment 517, and in a second 535 volumes of hydrogen at 30 inches bar. and 60 F., calculated on the volume of the zinc dust taken. I hope to be able to make further observations on the relations between zinc and hydrogen.

The Gas Light and Coke Company.
Dec. 9, 1885.

SEPARATION OF NICKEL AND COBALT.

By M. ILINSKI and G. VON KNORRE.

IF an alcohol, dilute alcoholic or acetic solution of nitroso- β -naphthol, is mixed with the solution of a cobalt salt, either neutral or acidified with hydrochloric acid, there is formed a bulky precipitate of a fine purple-red, permanent in presence of acids, alkalies, and oxidising and reducing agents. The compound obtained is cobaltinitroso- β -naphthol. The presence of cobalt cannot be shown by ordinary reagents, but on heating with ammonium sulphide the organic residue is reduced, and cobalt sulphide is formed. Cobaltinitroso- β -naphthol dissolves in red fuming nitric acid, and in oil of vitriol, but in both cases it is re-precipitated unchanged on the addition of water. Acetic acid at 50 per cent (sp. gr. 1.06) dissolves a trace of this compound on boiling, but on cooling it separates out again entirely. In strong alcohol it is moderately soluble, very slightly in aqueous spirit, and readily in aniline and phenol. From the aniline solution this compound is re-precipitated by hydrochloric acid. If heated it deflagrates, but a quiet incineration may be effected by previously adding oxalic acid. If the compound is boiled with strong potash-lye no action is at first perceptible, but when the liquid becomes very much concentrated a green colour appears, due to the formation of nitroso- β -naphthol potassium, which for the most part separates out. On diluting with water the cobalt compound is reproduced.

If a solution of nitroso- β -naphthol in 50 per cent acetic acid, or an aqueous solution of nitroso- β -naphthol sodium, is mixed with the solution of a nickel-salt, nitroso- β -naphthol nickel separates out as a yellowish brown precipitate. The compound thus obtained is sparingly soluble in water and alcohol; hydrochloric and sulphuric

* From the *Journal of Gas Lighting*.

† *Ibid.*, vol. xli., pp. 913, 960.

‡ *Ibid.*, vol. xlv., p. 15.

§ *Ibid.*, p. 485.

|| *Ibid.*, p. 645.

acids readily withdraw the nickel from it, with elimination of nitroso- β -naphthol, which remains in solution in presence of a sufficiency of acetic acid. If, therefore, an acetic solution of nitroso- β -naphthol is mixed with a little hydrochloric acid, and then with a salt of nickel, no precipitation takes place. Potash-lye gradually decomposes nitroso- β -naphthol nickel on heating.

From the above-mentioned behaviour of these cobalt- and nickel-compounds with hydrochloric acid, there results the following method for the separation of the two metals:—

The solution containing nickel and cobalt, as sulphates and chlorides (and in which iron and chrome must not be present), is mixed with a few c.c. of free hydrochloric acid. To the heated mixture there is added a hot solution of not too little nitroso- β -naphthol in 50 per cent acetic acid. The precipitate is allowed to settle, and when the liquid is cold it is examined if a further precipitation of the cobalti-compound takes place on the addition of more solution of nitroso-naphthol. If the precipitation is complete the deposit is filtered off after standing for some hours, and washed first with cold and then with hot hydrochloric acid, of about 12 per cent strength, and lastly with hot water. As the precipitate is very bulky the filter must be of sufficient size. To the dried precipitate are added a few knife-points full of crystalline oxalic acid, free from ash; the filter is folded up, and cautiously incinerated in a Rose's crucible at a gradually increasing temperature. It is then ignited in a current of hydrogen, and weighed as metallic cobalt. In the filtrate the nickel is precipitated, apparently quantitatively, by heating with potassium hydroxide after expulsion of the larger part of the acetic acid.

According to the authors, however, it is preferable to precipitate both nickel and cobalt in an aliquot part of the liquid with potassium hydroxide, to determine the cobalt as above in another aliquot portion, and to estimate the nickel as difference. The determinations made by the authors in this manner show very satisfactory results.

The sensitiveness of the reaction may be judged from the following experiments:—According to G. Vortmann 1 c.c. of a cobalt solution, containing 0.00059 of a gram. of cobalt mixed with potassium nitrite and acetic acid, occasioned a distinct turbidity only after half an hour, and a slight precipitate of Fischer's salt at the end of two hours. One c.c. of the same solution, mixed with a little acetic and hydrochloric acid, gave, on the addition of a few drops of an acetic solution of nitroso-naphthol, an immediate red turbidity, and in a few minutes a red precipitate: 0.2 c.c. of a cobalt solution (0.00004 gram. Co) and 5 c.c. of a nickel solution (0.0105 gram. Ni) gave at once a brick-red turbidity on the addition of a solution of nitroso-naphthol, and after some time red flocks of the cobalti-compound separated out.

The following method is found by Henriques and Ilinski most suitable for preparing nitroso- β -naphthol:—1 part of commercial β -naphthol with 0.75 part of zinc chloride is dissolved in 6 parts of alcohol. If to the boiling solution thus obtained there is added a concentrated aqueous solution of 0.5 part of sodium nitrite, the liquid soon turns red, and after a short ebullition the reddish brown zinc salt of nitroso-naphthol begins to separate out. It is left stand over night, the salt is filtered off and washed with a little alcohol. In the mother-liquor are found small quantities of resinous products, undecomposed naphthol, &c. The zinc salt is stirred up with about 10 parts of water and digested for a short time with a solution of 0.8—1 part of soda until the whole is converted into the greenish crystalline sodium salt, whilst the zinc passes into solution. When cold the sodium salt is filtered off, washed with a little water, and then at once decomposed in the cold with hydrochloric acid, not too dilute. Thus, after filtering and washing there is obtained nitroso-naphthol almost chemically pure. If further purification is desired the product may be dissolved in soda, and the liquid, after fil-

tration, re-precipitated with sulphuric acid. The yield is from 110 to 115 per cent of the naphthol employed.—*Zeitschrift für Anal. Chemie* and *Berichte der Deutschen Chem. Gesell.*

THE INFLUENCE OF MAGNETISM UPON THE CHARACTER OF THE SPECTRAL LINES.

By Ch. FIEVEZ.

FARADAY'S discovery (1846) of the rotation of the plane of polarisation of light under the influence of magnetic forces made manifest the relation existing between polarised light, magnetism, and electricity.

The action of magnetism upon the electric spark whilst passing through highly rarefied gases was plainly shown by the researches of De la Rive, and by the spectroscopic experiments of Trève, Daniel, Secchi, and Capron.

According to De la Rive and Daniel, this phenomenon obeys the laws of electro-dynamics, and the results observed, the increased luminous power of the spark and of its spectrum are due to a local condensation of the gaseous medium. Secchi, on the other hand, ascribes them to the diamagnetism of the gases, *i.e.*, to a repulsion which the magnet exerts upon the rarefied gases, occasioning a strong diminution of the gaseous surface in the section of the tube traversed, and thereby an elevation of temperature.

According to these physicists, the influence of magnetism upon a spark traversing rarefied gases depends merely in a change of the resistance of the gases thus traversed. Cazin has also concluded from Secchi's experiments "that there is no spectrum peculiar to magnetism, *i.e.*, that the magnet exerts no direct action upon the rays emanating from the source of light."

This inference, however, goes beyond the known facts, for nothing forbids us, on the other hand, to ascribe the increased luminosity of the spark and its spectrum to the action of the magnetism upon the luminous rays themselves.

However this may be, the question may be answered more accurately, even if perhaps not as yet finally, and that by means of experiments where magnetic forces may act upon the movement of light and heat without anything intermediate save ponderable matter. Magnetic experiments with flames fulfil these conditions.

The influence exerted by magnetism upon the direction of flames has long been observed, and it is known that all flames display the same phenomena in different degrees. It has only to be decided whether the magnetic action is confined to a change in the direction of the gaseous masses, or whether it extends to the luminous undulations themselves.

Although spectral analysis might decide this question, it is necessary to combine the most favourable conditions of magnetic intensity and of the dispersion of light in order that the spectral modifications produced may not escape observations.

The spectroscopic appliances of the Brussels Observatory, including a very powerful dispersion apparatus and a Faraday's electro-magnet constructed by Ruhmkorff, which is excited by a current of 50 Ampères, enabled the author to attempt the solution of this question.

The oxy-hydrogen flame of a small blast was driven horizontally upon a piece of charcoal saturated with soda placed between the conical keepers of the electro-magnet, which were at 10 millimetres distance from each other. An image of the flames was thrown by a double objective upon the slit of the spectroscope. The quantity of oxygen introduced into the flame permitted the temperature to be regulated in such a manner that the spectral lines D_1 and D_2 could be made to appear at pleasure.

Under these conditions the sodium lines D_1 and D_2 , which prior to the passage of the magnetising current were but narrow and not inverted, became immediately

longer, broader, and more luminous as soon as the electro-magnet was set in action.

If the luminous lines D_1 and D_2 are already broad before the electro-magnet is brought into play they become still broader, and are inverted (*i.e.*, there appears a black line in the centre of the broad luminous band) during the transit of the magnetising current.

If the bands are already expanded and inverted, the expansion both of the luminous band and of the black line increase considerably.

These phenomena, which immediately disappear on the interruption of the current, can also be observed, though with less intensity, in the red line of potassium or lithium, in the green line of thallium, &c., if a trace of these metals or of their salts is laid upon the charcoal.

If instead of the conical armatures of the electro-magnet we use flat ones, so that the entire length of the flame is between the armatures, the lines D_1 and D_2 , which are already extended and inverted, display a double inversion (*i.e.*, a shining line appears in the middle of the black line) when the electro-magnet is set in action.

These experiments, which demonstrate the influence of magnetism upon the luminous undulations without the intervention of the electric spark, show likewise that the phenomena which appear under the influence of magnetism are identical with those produced by an elevation of temperature.

The spectrum of a flame which coincides with the direction of the magnetic axis undergoes the same changes under the influence of magnetism as that of a flame perpendicular to this axis.—*Acad. de Bruxelles*, [3], vol. ix. (1885).

CALORIFIC POWER OF FUEL.

By JOJI SAKURAI,
Professor of Chemistry, Tokio University, Japan.

IN "Watts's Dictionary," vol. ii., there is an excellent article on "Fuel," written by Dr. Benjamin H. Paul, where a method for calculating the calorific power of fuel is given. Thus, after speaking of the relative calorific power of hydrogen and carbon, and of the effects of oxygen contained in a fuel, he says on page 723:—

"The relative calorific power of fuel may be calculated by means of the following formulæ, in which p represents the relative calorific power, and C, H, O represent the amounts of carbon, hydrogen, and oxygen in one part of the fuel:—

- "1. Fuel containing only carbon $p = C$.
- "2. Fuel containing carbon and hydrogen $p = C + 4.265 H$.
- "3. Fuel containing carbon, hydrogen, and oxygen } or, $p = C - \frac{8}{16}O + 4.265 H$,
hydrogen, and oxygen } $p = C + 4.265 (H - \frac{1}{8}O)$

"If it is desired to express the calorific power of fuel in heat units, the amount of carbon and the amount of available hydrogen in one part of the fuel are to be respectively multiplied by the numbers expressing the calorific power of carbon and of hydrogen, and the sum of the two products represents the relative calorific power of the fuel in heat units:—

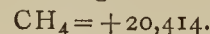
1. $p = 8080 C$.
2. $p = 8080 C + 34462 H$.
3. $p = 8080 C + 34462 (H - \frac{1}{8}O)$."

Then he gives a table, in which the relative calorific powers of several combustibles are given, as calculated from their composition according to the above formulæ, and from which I here reproduce a few figures:—

Fuel.	Composition of Fuel.				Calorific Power in Heat-units.
	Carbon.	Hydrogen.	Oxygen.	Ash.	
Hydrogen	—	1.00	—	—	34,462
Marsh-gas	0.750	0.250	—	—	14,675
Olefiant gas ..	0.857	0.143	—	—	11,849
Av. Welsh coal ..	0.838	0.048	0.041	0.090	8,241

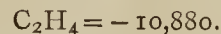
The number 14,675, which is the sum of the quantities of heat evolved by carbon and hydrogen separately, is therefore regarded as the relative calorific power of marsh-gas, a view which is similar to stating that marsh-gas is a mixture of carbon and hydrogen.

As everyone knows, the researches of Thomsen and Berthelot have shown us that the calorific power of a hydrocarbon is not equal to the sum of the quantities of heat evolved by the carbon and the hydrogen separately,—that, in fact, we must take into account the heat which is evolved or absorbed by the separation of carbon and hydrogen from each other. According to Thomsen, the heat of formation of marsh-gas is—



This quantity of heat is therefore absorbed during the decomposition of 16 parts of marsh-gas into carbon and hydrogen, and hence the actual heat of combustion for 1 part of marsh-gas must be about 1276 units less than the number found in the above table.

Again, when olefiant gas is decomposed into carbon and hydrogen there is evolved some heat, and hence the actual heat of combustion of that hydrocarbon must be greater than that in the table. According to Thomsen we have—



Hence, the decomposition of 1 part of olefiant gas into carbon and hydrogen evolves about 389 units of heat, and hence the calorific power of olefiant gas should be 12,238 heat units.

Lastly, coal is evidently not a mere mixture of carbon, hydrogen, &c., but is a chemical compound of some sort, and hence the calculation of its calorific power according to the above formulæ is not only useless, but is also erroneous.

There is, so far as I am aware, no formula by which the calorific power of fuel may be calculated. The only way is to resort to actual experiments.

It is unfortunate that no correction has been made in the subsequent volumes of "Watts's Dictionary" as to the point above referred to; nor has anyone, so far as I can ascertain, pointed out the error.

Not only is that the case, but even in some of the very recently published books we read similar statements. For example, on p. 43, Part II., of Mr. C. J. Woodward's excellent little book called "Arithmetical Chemistry," the following statement occurs:—

"The calorific power of coal, of which the percentage composition is given, is calculated in the same way (that is, by adding together the calorific powers of carbon and hydrogen contained in the coal: J.S.), but, of course, any nitrogen or ash the coal may contain must be disregarded; and, further, if oxygen be present in the coal, a quantity of hydrogen or carbon, or the two together, sufficient to combine with this oxygen, must be deducted."

October 19, 1885.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN
General Monthly Meeting, Monday, December 7, 1885.

GEORGE BUSK, Esq., F.R.S., Treasurer and Vice-President,
in the chair.

THE following gentlemen were elected Members:—James Butcher and Charles Bell Eustace Ford.

Seven Candidates for Membership were proposed for election.

The Presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

The following Lecture Arrangements were announced :—

Professor Dewar, M.A., F.R.S., M.R.I., Fullerian Professor of Chemistry, R.I.—Six Lectures (adapted to a Juvenile Auditory) on "The Story of a Meteorite." On Dec. 29 (Tuesday), Dec. 31, 1885; Jan. 2, 5, 7, 9, 1886.

Robert Stawell Ball, LL.D., F.R.S., Andrews Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland.—Three Lectures on "The Astronomical Theory of the Great Ice Age." On Tuesday, Jan. 19; Thursday, Jan. 21; Saturday, Jan. 23.

Reginald Stuart Poole, LL.D., of the British Museum, Corresp. Inst. France.—Three Lectures on "Naucratis." (1) "Relations of the Greeks with Egypt from the Heroic Age to Psammitichas"; (2) "The Emporium of Naucratis"; (3) "The Egyptian Sources of Greek Art." On Tuesdays, Jan. 26, Feb. 2, 9.

Charles T. Newton, C.B., LL.D., M.A.—Three Lectures on "The Unexhibited Portion of the Greek and Roman Sculptures in the British Museum (illustrated by Drawings and Casts). On Tuesdays, Feb. 16, 23, March 2.

Professor Arthur Gamgee, M.D., F.R.S., Fullerian Professor of Physiology, R.I.—Six Lectures on "The Function of Circulation." On Tuesdays, March 9, 16, 23, 30, April 6, 13.

Wm. Chandler Roberts-Austen, F.R.S., M.R.I., Chemist to the Royal Mint.—Four Lectures on "Metals as Affected by Small Quantities of Impurity." On Thursdays, Jan. 28, Feb. 4, 11, 18.

Professor W. Boyd Dawkins, M.A., F.R.S., F.G.S.—Four Lectures on "The Ancient Geography of Britain." On Thursdays, Feb. 25, March 4, 11, 18.

Professor Tyndall, D.C.L., LL.D., F.R.S., M.R.I.—Four Lectures on "Light." On Thursdays, March 25, April 1, 8, 15.

Archibald Geikie, LL.D., F.R.S., Director-General of the Geological Survey of the United Kingdom.—Four Lectures on "The History of Volcanic Action in the British Isles." On Saturdays, Jan. 30, Feb. 6, 13, 20.

Rev. C. Taylor, D.D., Master of St. John's College, Cambridge.—Two Lectures on "The History of Geometry: the Greeks and the Moderns." On Saturdays, Feb. 27, March 6.

Edward B. Poulton, M.A.—Two Lectures on "The Nature and Protective Use of Colour in Caterpillars." On Saturdays, March 13, 20.

Howard Grubb, F.R.S.—Two Lectures on "The Astronomical Telescope." On Saturdays, March 27, April 3.

Professor Oliver Lodge, D.Sc.—Two Lectures on "Fuel and Smoke." On Saturdays, April 10, 17.

here conveyed we fully agree. The writer of a text-book—as distinguished from books of reference and treatises which aim at expounding the sum total of human knowledge in any given department—should join to a full acquaintance with his subject a mastery of the art of instruction. The most eminent *savant* may fail utterly as a teacher, either verbally or in writing.

Mr. Wormell directs the attention of the student only to one difficulty at a time. Where there are mixed phenomena, one of them is for the time being discussed as if it were the only one; the entire truth is given in parts, which are gradually wrought together into a coherent whole. This method, from the instances met with, seems to us eminently rational and likely to prove useful.

The arrangement of the subject-matter is somewhat peculiar, heat being considered first, then sound, and lastly light. The author remarks that this is a departure from the arrangement adopted by the "Science and Art Department, which places sound first and heat last." In so doing he considers that it is "clearly of greater importance that the course of teaching shall conform to the natural order of progression from the simple to the complex than to a scheme of examination in which the opposite course seems to be indicated." It is perfectly possible that the author's arrangement may prove the best for teaching. Still it seems doubtfully legitimate to separate the consideration of heat and light agencies so near of kin, and playing such an important part in the universe, and to intercalate between them an agency, so to speak, of lower rank.

At the end of the book we find a quantity of the *banal* examination papers which so strikingly distinguish English manuals from those used, *e.g.*, in Germany. Those here given are from the College of Preceptors and from the Science and Art Department. Like all collections of questions of this kind they will be doubtless of some use to "coaches" and to persons being "coached," though both these classes are generally provided with more extensive tables from which the idiosyncracies of particular examiners and the probability of any question recurring may be approximately deduced.

The use of such "papers" to persons who are honestly seeking for a knowledge of physics without reference to "the iron tyrant, Examination" might not be easy to demonstrate. We have heard men who are successfully engaged in widening the bounds of knowledge frankly declare that if they were called upon to submit to an examination in their own experimental results they would infallibly be "plucked."

NOTICES OF BOOKS.

Lectures on Heat, Sound, and Light: an Elementary Text-book for Students. By RICHARD WORMELL, D.Sc., M.A., Head Master of the City of London Middle Class Schools. London: Thomas Murby.

THE author of this work, which forms one of the "High School Science Series," admits in his preface that elementary text-books on physics are already so numerous that any addition to their number requires some justification. The *raison d'être* of the work he would place, not so much in the subject-matter, which scarcely offers scope for any novelty, as on its educational method. He writes :—"These lectures are based on considerations and characterised by features which, though of great and acknowledged importance in education, do not usually find their way into text-books; . . . a main feature of this work . . . will be found in its gradually progressive character; a feature which, so far as we know, is quite novel in works of this kind, and the importance of which will be obvious to the practical teacher." With the views

Numerical Examples in Heat. By R. E. DAY, M.A. London: Longmans, Green, and Co.

THE nature of this book can at once be inferred from the title. The author remarks in his preface—"Considering that a knowledge of physical science which cannot be reduced to concrete numbers is no real knowledge at all it is very important that at an early stage of his work the student should have plenty of practice in applying the facts and theories which he reads about in his text-book to the numerical solutions of such questions as are of frequent occurrence in the practical applications of the subject." All this is perfectly true. Mere reading about facts and theories in a text-book is very little; solving problems numerically is a great deal more; but there is still a more excellent way, without which it is impossible to become a discoverer, or even to obtain the intellectual training which the study of physics offers. The first thing to be learned is how to observe phenomena, so as to recognise their minutest features. Intimately connected with this is the art of experimentation—or, in other words, the systematic examination and cross-examination of Nature. Lastly, comes the art of drawing right conclusions from the phenomena observed. If we do not become masters of these three arts we miss the educational function of

physics altogether. We should be inclined to say, borrowing *mutatis mutandis* the advice of an eminent professor concerning the study of botany,—“Begin with the phenomena themselves, and use text-books and manuals like that before us afterwards to co-ordinate what you have observed!” Mere words and figures do not make the investigator.

A very commendable feature in the book before us is that we trace in it no reference to examinations.

Arithmetical Physics. Part II. B: Magnetism and Electricity (Degree and Honours Stages). By C. J. WOODWARD, B.Sc., Principal Chemistry and Physics Department, Birmingham and Midland Institute. London: Simpkin, Marshall, and Co. Birmingham: Cornish Bros.

ELEMENTARY works on physics are threatening to become as numerous as those on chemistry, and both the practical educator and the reviewer are often sorely perplexed to give any one of such manuals a clearly marked superiority over its rivals.

The book before us belongs to a particular class which has recently come into favour, and which has admittedly certain very decided advantages as compared with the manuals of some half-century ago, in which the pupil merely read of phenomena.

Mr. Woodward's point of view is distinctly examinational, as appears from the very words on the title-page, “Degree and Honours Stages.” Will the public never see that degrees and honours should be gained, not by the mere reproduction of what has been already known, but by original research, which is in itself the best, or it might rather be said the only, proofs of a mastery of any science? Twenty-one pages out of a total of 126 are here taken up with questions set by the Science and Art Department and by the examiners of the University of London.

At the end of the book we find the advertisement of another work by the same author, entitled “University of London Questions,” and comprising “the whole of the questions in natural philosophy and chemistry given at the matriculation examinations from 1864 to 1882.” This compilation, it is said, “must be useful to a large circle of teachers and students.” We do not in the least call this opinion in question. Mr. Woodward's work is, in its kind, unexceptionable, but the kind is not the best.

CORRESPONDENCE.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—In the number of *Nature* for the 26th of November last (p. 73) there appeared an editorial article headed “The Whole Duty of a Chemist,” containing criticisms on the scope and objects of the Institute of Chemistry, and a thinly-veiled personal attack upon the President. In common with other colleagues, I have felt surprise and regret at the numerous mis-statements contained in the article, and at the contemptuous tone adopted throughout the reproof which the writer has “felt it his bounden duty” to administer to the members of the Institute. And it is only an expression of the opinion of many, when I earnestly deprecate the introduction of ill-natured personalities (such as are common enough in the so-called “Society Papers”) into a scientific journal.

I will not further allude to the personal portion of the article, as Professor Odling has already dealt with that in the columns of *Nature*; but as I have been associated with and greatly interested in the progress of this Institute from its foundation, and have felt the great need

for a definite bond associating chemists in a common work, for the improvement of the training and education of professional chemists, for the raising of the standard of professional work, and for the promotion and encouragement of a uniformly high tone and spirit in its performance, I will ask you to give me space to defend the Institute against the gross misrepresentations contained in *Nature*, since the editor has thought fit to close his journal against my criticisms.

The editor of *Nature* implies that, in common with “all true men of science,” he considers the creation of the new Chartered Corporation as an event quite beneath notice in his journal, except on account of the interest resulting from the “consideration of its prospective influence on the progress of science.” He seems to think that there can be nothing great, noble, or truly beneficial for mankind, except original research. The physician, surgeon, and engineer, whom he classifies with the tailor and bootmaker, may be respectable members of society, but they are quite beneath the notice of the “student of pure science.” They are unworthy of his sympathy or gratitude, however much their knowledge and skill may benefit their fellow-men, inasmuch as they make a livelihood by their several professions. Such a grotesque representation of the relative positions of researchers and professionals is not calculated to commend itself to either class, and will certainly not tend to increase the popularity of the former.

The Institute does hope to do for its members what the College of Physicians and the College of Surgeons have done for theirs, by formally including them within the ranks of a learned profession; while the world at large must benefit by the setting up of a high standard of scientific knowledge and proficiency. Its object is certainly not, as the writer states, that of the “modern trades-unions.” The President distinctly and truly said in his address, “It does not lay itself out, nor is it fitted, for the exercise of what may be called a trades-union method of proceeding.” It is not true, as stated in the article, that “the intention is entirely commercial.” On the contrary, its chief intentions are educational and ethical. The editor of *Nature* is pleased to pronounce the medical education of the day as “the worst organised and least effective.” Even admitting this to be the case, which I am far from doing, surely its improvement would not be promoted by abolishing all organisation, and leaving medical students to develop into practitioners simply according to their own inclinations. Such was the condition of things in the chemical profession before the foundation of the Institute in 1876. Already, however, its action has very materially raised the standard both of special and general training amongst those who have presented themselves for examination, and several original investigations have been made by candidates with special reference to their admission to the Associateship. The rapid increase in the number of applications of chemistry to agriculture, manufactures, public health, the service of the State, and the daily wants of modern civilisation, has, for many years past, conferred upon professional chemistry an importance scarcely second to that of other professions which have been similarly called into existence by the urgent wants of society; and, like them, it required organisation and suitable scientific training for its creditable and successful practice.

The curriculum prescribed for the lower degree of Associate includes a thorough training in theoretical and practical chemistry, an original research, conducted by the candidate, being considered a specially high recommendation. In addition, he is required to pass satisfactory examinations in physics and mathematics, and is always specially examined by the officers of the Institute in practical chemistry. This examination, which extends over several days, is conducted in properly-equipped laboratories by the following official examiners:—Prof. W. A. Tilden, D.Sc., F.R.S., for Birmingham; Prof. Ramsay, Ph.D., for Bristol; Prof. W. N. Hartley, F.R.S., for Dublin; Prof. E. J. Mills, D.Sc., F.R.S., for Glasgow;

Prof. Charles Graham, D.Sc., for London; and Mr. Watson Smith, for Manchester. These are names of world-wide reputation, and I leave your readers to judge how far an Institution having such objects, performing such functions, and including in its register the name of nearly every chemist of eminence in the United Kingdom, deserves the contempt and reproach with which it has been assailed in the columns of *Nature*.

Unlike the editor of that journal, I consider that the President of the Institute was particularly happy in his delineation of the status and character of the professional as distinguished from the professorial or tutorial man of science. There is a great deal of flabby sentimentalism abroad in reference to the earning of fees by scientific men, and it was high time that its hollowness should be exposed. It is said that this sentimentalism has even in some cases taken the form of so drawing the conditions of appointment as to prohibit the occupants of professorial chairs from taking part in any technical inquiry, however important. It is my deliberate conviction that this complete divorce of science from practice is most disadvantageous to the man of science, to the national welfare, and even to the progress of scientific investigation. Such a prohibition effectually cuts off the professor from one of the most important and valuable sources of scientific knowledge, and decidedly impairs his capacity for teaching, inasmuch as it deprives him of the opportunity of acquaintance with the most recent applications and problems of science. Without travelling beyond the United Kingdom, I may mention the names of Faraday, Graham, Brande, Miller, Gregory, Anderson, Stenhouse, Brodie, Kane, and Hofmann as those of men who have all applied their science to the utilities of the day, and have received honourable payment for the same; and whilst thus affording valuable aid to others, they materially widened and deepened their own scientific knowledge. As for my own experience, the training I have received from work of this kind has been of inestimable service to me, not only as a teacher, but also as an investigator, for it has suggested several inquiries which were subsequently pursued in my own laboratory. Of course this technical work should not be undertaken to such an extent as to interfere with the teacher's tutorial duties.

The editor of *Nature* waxes grandiloquent over the high dignity of the investigator, and asserts that the endowment of research is not for the *benefit* of the researcher. As a matter of fact, however, researchers have been and still are endowed from the National Exchequer to enable them to live whilst making their investigations. If it be said that this is not benefitting the researcher, such an assertion is quite incompatible with the notion expressed in the same article "that his whole heart is in his researches." It is well known that original investigation is a source of the greatest pleasure and delight, and taking this into account, I have heard an eminent discoverer, now on the Bench, say that instead of being endowed, researchers ought rather to pay for this the highest gratification of their wishes. This is no doubt an extreme view, but I can scarcely imagine a greater "benefit" to the researcher, than having his sustenance and expenses provided for him by others, in order that he may devote himself to his favourite pursuits. I am not deprecating the endowment of research. Much may be said on both sides of this subject, but when you catch your genuine researcher it is undoubtedly for the national good that he should be endowed. On the whole, however, I agree with Professor Odling that "the best of all endowments for research is that with which the searcher, relying on his own energies, succeeds in endowing himself."

The writer's bitter remarks on experts are perhaps not altogether undeserved, but the fault is by no means entirely theirs. It is to be attributed much more to the disgraceful state of the law relating to their evidence. Probably in no other civilised country in the world is the expert precluded from acquaintance with both sides of the question before giving his opinion. What sort of re-

sult would attend a trial at law if it were conducted by two judges, one of whom was permitted to hear only the case for the plaintiff, and the other only that for the defendant—the separate judgment of each to be given without previous consultation! So far as the fault rests with the expert, it is the duty of the Censors of the Institute to deal with it. Every unprejudiced mind will admit that the more extensive and accurate knowledge, and the high moral tone which our Corporation seeks to promote, must tend to its rectification, whilst the "not too much knowledge or conscience" which the editor of *Nature* consoles himself in thinking are amongst the most valuable qualities in an expert, would as certainly tend in the opposite direction.

Experts are, however, rare in the Institute; the great mass of its members consists of chemists in factories, public analysts, and chemists in Government departments and in the employ of the Corporations of our large towns. These are supplemented by professors, teachers, and manufacturers, who never perform commercial analyses or appear in courts of law, but who consider that the better training of young chemists, most of whom must of necessity earn their livelihood by the exercise of their professions, is an object which it is desirable to encourage.

Of the hundreds of chemists who are annually turned out of our laboratories more or less educated, few can become State-endowed researchers. Is it not to be wished that the large residue should be well educated and properly trained for the work they have to do in the world? To some of them problems will be submitted involving the success or failure of large industries, and upon all of them, who follow their profession, will rest the duty of maintaining, so far as chemistry is concerned, our national supremacy in arts and manufactures. Those of them endowed with the true spirit of research will rarely fail to find time for an occupation which promises them the keenest pleasure. It would indeed be well if those who inherit wealth would qualify themselves for the investigation of *Nature*, but, unfortunately, this is rarely the case, and hitherto the progress of science has depended mainly upon the work of men who have had to earn their own livelihood.

Reasoning from the fact that the medical profession, in consequence of its scientific training, has very largely recruited the ranks of investigators, it is not too much to expect that the Institute of Chemistry, with its far more specialised curriculum, will at least equally distinguish itself by the evolution of experimental inquirers. It must be borne in mind, however, that besides original research, there are other things in the world which deserve the support and encouragement of the man of science: and whilst yielding to none in our estimate of the great value of research, we must not forget that it is by no means "the whole duty of a chemist."—I am, &c.,

E. FRANKLAND.

The Yews, Reigate, December 12, 1885.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—I am glad to find that the letter which you did me the favour of publishing (*CHEMICAL NEWS*, vol. lii., p. 272) has called forth some expressions of opinion from a few readers. It is now an open secret that some members of the Council are endeavouring to set aside the examination test in order that a number of persons, more or less "qualified in the opinion of the Council," may be admitted to the enjoyment of such rights and privileges as the Institute may be able to confer upon its members. Your correspondent "F.C.S." remarks that this, if carried out, would be a distinctly retrograde step. It would be worse; it would, I think, be a decidedly disastrous one, involving no doubt the resignation of most of the best members, unquestionably tending to bring the Institute into con-

tempt, and rendering impossible the obtaining of an Act of Parliament whereby the Institute's diploma would become legally necessary for practice.

What is the *raison d'être* of the Institute of Chemistry? It exists presumably for the main purpose of raising the *status* of the chemical profession—a thing which is now pretty generally recognised to be an absolute necessity. Is this likely to be accomplished by such methods as those advocated by your three correspondents "A Teacher," "J." and "Non F.I.C."? The tone of "Non F.I.C.'s" letter is sufficiently explained by his signature. It would no doubt be extremely pleasant and convenient for some people to be granted a diploma on the "proposal of two or more Fellows" after serving for a time as an "articled pupil." I should be glad to know whether such a course would commend itself to your correspondents in regard to the granting of *medical* diplomas. "A Teacher" says he "firmly believes" that the "evidence of fitness" test is superior to the examination one. Now everybody knows, or ought to know, how the "evidence of fitness" test works. A fairly good example is furnished by the Chemical Society itself. Few people will deny that there are a fair number of persons in the Society who have literally no business in it. It is impossible for a Council to examine into "evidence of fitness." Any attempt to do so must sooner or later degenerate into a farce. Whatever may be said against examinations—and there is certainly much to be said against them—they furnish at present the only safe test, and the only one which will command any respect from the public. I know very well that the majority of F.I.C.'s were admitted without examination. This was obviously necessary when the Institute was founded, and will again become necessary if a legal enactment is obtained making the Institute's diploma compulsory for practice; but it is surely not a reason for opening the doors on every available opportunity. The remarkable shallowness of the excuse used in the present instance—viz., the granting of a Royal Charter—is pointed out by "F.C.S."

It cannot have become necessary to recruit the ranks of the Institute in any such manner. Money cannot be wanted, for the expenses are not enormous. The office on Adelphi Terrace is not palatial, and I am not aware that any expensive benefits have been showered upon the general body of members in return for their subscriptions and their examination fees. No "new and vigorous blood" can possibly be infused into the Institute by the carrying out of the proposal in question, but rather "blood" of a kind the absence of which would probably be desirable.

In any case I protest most strongly—and I sincerely hope that others will protest with me—against any such change being carried out in a "hole and corner" fashion. A matter of such vital importance should not be left in the hands of the Council, but should be submitted to every member of the Institute for his opinion. If this be done, as I trust it may be, I firmly believe that common sense and justice will prevail, and that the proposition will be defeated by an overwhelming majority.—I am, &c.,

F.I.C.

December 8, 1885.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—“F.C.S. (CHEMICAL NEWS, vol. ii., p. 282) says:—“kept on paying subscriptions, only receiving the vague honour of being able to add three comparatively unknown letters to their names.” Certainly the honour (!) is vague. If the council placed the Institute on a footing similar to that of the Incorporated Law Society—imitating the Law Society—so far as to prevent anyone practising without having a certificate from the Institute: this certificate to be obtained on the candidate producing “*evidence of fitness*”; the student on completion of his articles

and “*evidence of fitness*,” this procedure would be really useful; but to apply the examination system to professional and analytical chemistry and chemical engineering (consulting only) is absurd in the extreme.—I am, &c.,

J. BATEMAN FAUDELLE.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—I am glad to hear—although only a rumour—that the Institute of Chemistry is contemplating an addition to or alteration of their rules which deal with the admittance of Fellows,—this alteration to enable professional chemists to join the Institute on “*evidence of fitness*.” If a rule is framed to embrace this the result will be, I am convinced, that all professional chemists of reputation will assist to place themselves on legal grounds by joining the Institute.

As for the rules now standing they effectually prevent such men joining as chemists employed solely in steel and iron works, chemical research, print and dye, &c., works. Such men as these have not time, opportunity, and, probably, the needful means to prepare for the Institute's examinations. These examinations are drawn up apparently for the purpose of *forcing* students into the almost unlimited “colleges” and “universities” we now have.—I am, &c.,

A STEEL AND IRON WORKS CHEMIST.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—The correspondence which has commenced in your columns appears to be of importance to many chemists who, like myself, have never had the advantage of a College or University training, and are not likely to have, and who are on that account debarred (if I am rightly informed) from Fellowship of the Institute.

If the Fellowship is to become, either now or at any future time, in any sense a necessary qualification for a chemist who hopes for success in his profession, surely it is most unfair to impose any condition which cannot be complied with by all competent chemists. I have held the position of chemist to a large commercial undertaking for the last five years, and hope I am qualified to continue to practise as an analytical chemist; but if Fellowship of the Institute is to be considered the certificate of competency, I fear I must be content to be classed, together with many chemists better qualified than myself, as incompetent, until such time as the Council think proper to alter the regulations for admission.

Seeing that a large number, perhaps the majority, of the existing Fellows were admitted simply on “evidence of fitness,” I cannot exactly see why “nothing can excuse such a proceeding as the one said to be in contemplation,” viz., the further admission of Fellows on such evidence. I hope “F.I.C.” was not so admitted.—I am, &c.,

NON-F.I.C. No. 2.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—With reference to the question of admission to the Institute of Chemistry “upon evidence of fitness satisfactory to the Council,” I quite agree with those of your correspondents who think that such a step would be a very serious move in the wrong direction.

The result of such a move would simply be to bring the Institute into competition with the Chemical Society and the Society of Chemical Industry, and as no special bene-

fits would accrue from membership of the Institute under such regulations for admission, it would speedily decrease in numbers, and in a very little time become extinct.

As one of your correspondents pithily remarks, "Exclusiveness is the only *raison d'être* for the Institute as it exists side by side with the Chemical Society and the Society of Chemical Industry."

I quite agree with those, however, who think that the present regulations ought to be very much modified: evidence of three years' training in any laboratory ought to be accepted in place of the three years' course in some University. The latter regulation excludes from the Institute many who in other respects are quite as well qualified as those who have had a University training.

The examinations I would still keep up, although I think the test of practical knowledge might be so arranged that it could be undergone by the candidates in their own laboratories. For instance, samples of certain substances might be sent to the several candidates, and the analyses made in their own laboratories, the results to be sent in by a certain date.

As one of your correspondents remarks, very few chemists could make an accurate analysis in a strange laboratory under the eyes of an examiner.

The success of the Institute depends, I am perfectly sure, upon the modification of the present regulations; not upon "throwing wide its doors to all sorts and conditions of chemists."—I am, &c.,

St. Helens, December 14, 1885.

A NON-F.I.C.

MICRO-ORGANISMS IN WATER.

To the Editor of the Chemical News.

SIR,—It was with much interest that I read in the *CHEMICAL NEWS* (vol. lii., p. 275) the account of Dr. T. Leone's experiments on the rapidity with which micro-organisms may become multiplied in water by standing. I investigated this subject at the commencement of the year, and it is, therefore, with especial interest that I see my results confirmed by those of Dr. Leone. The experiments which I instituted in order to demonstrate this point were the following (I quote from a paper on "The Removal of Micro-organisms from Water," published last June in the *Proceedings of the Royal Society*, No. 238, p. 387):—About 10 litres of ordinary distilled water were inoculated with a few drops of diluted urine containing an abundance of micro-organisms. This infected water was placed in three sterilised Winchester quart bottles plugged with sterilised cotton-wool, and these bottles were then left at perfect rest in a room, the average temperature of which was 10° C. during the daytime. The number of organisms in the water was ascertained by the gelatin method, at the outset of the experiments; again at the end of six hours the number was determined in one of the bottles, at the end of twenty-four hours in the second bottle, and lastly at the end of forty-eight hours in the third bottle. The numbers found were as follows:—

Hours of Subsidence.	No. of Organisms in 1 c.c.
0 (morning)	1073
6 (evening)	6028
24 (morning)	7262
48 (morning)	48,100

The comparatively small increase between the sixth and twenty-fourth hour is accounted for by the low temperature which must have prevailed in the laboratory during the winter night, the increase during the first six hours being during the daytime.

I also found that when a water is softened by Clark's process a large proportion of the microbia present are precipitated, but that on standing at rest for a few days the clear supernatant liquid becomes more highly charged with micro-organisms than it was before treatment. In

applying the gelatin process to the examination of potable water it is necessary, therefore, that the samples should be submitted to examination as soon as possible after collection, and that during any unavoidable interval they should be preserved in a cool place, so that the multiplication of the micro-organisms be reduced to a minimum. That if these precautions be observed no appreciable multiplication takes place is evident from the fact that in some of the London waters I have repeatedly found as few as two organisms in the cubic centimetre, even when the sample has been preserved for nearly twenty-four hours.—I am, &c.,

PERCY F. FRANKLAND.

Grove House, Pembroke Square, W.,
December 14, 1885.

A CHRISTMAS CONTRIBUTION TO THE LITERATURE OF EXPLOSIVES.

To the Editor of the Chemical News.

SIR,—As a seasonable supplement to Prof. Munroe's useful "Notes" I beg to send you the enclosed Patent, which Her Majesty's Commissioners of Patents for Inventions were pleased to grant to Mr. —, Chemist in the City of London, early in 1870.—I am, &c.,

H. S.

December 13, 1885.

I, —, in the City of London, Chemist, do hereby declare the nature of the said Invention for "A New or Improved Compound or Explosive Mixture to be used as a Substitute for Gunpowder," to be as follows:—

My invention relates to the combination of materials or substances for producing an explosive compound to be used as a substitute for gunpowder in blasting, fire-arms, and other similar purposes.

I take a quantity of flinty or chalky material and reduce the same to powder in the ordinary manner. I then remove the chloride or carbonate of chalk, as is usual, and place a certain quantity of it in a vessel in which some urine is placed; this mixture is heated over a fire until it boils, and the boiling is continued until all the urine is evaporated, and the mixture is nearly dry; it is then removed and laid or spread out on a fabric to finally dry it, when the substance will be found to be in crystals. A little salt is thrown upon the surface of the mixture while in the vessel to assist the crystallisation. When the mixture is thoroughly dry I mix a certain quantity of charcoal with it, and after a few days it will be fit for use. A compound of any colour may be produced by mixing a quantity of colouring matter with it.

As an example of the proportions of the different materials I prefer I give the following:—

Carbonate of chalk	125 grms.
Chloride of sodium	65 "
Urine sufficient to cover the material in vessel.	
Charcoal	35 grms.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Journal für Praktische Chemie.

New Series, Vol. xxxii., Parts 4 and 5.

Action of Phosphorus Pentachloride upon Meconic Acid.—E. Hilsenbein has not succeeded in effecting the conversion of meconic acid into chlorinised chelidonic acid by treatment with phosphorus pentachloride and decom-

posing the chloride thus formed with water. He has obtained, however, two very interesting colouring-matters which he designates meken-blue and meken-red. The former of these is obtained by dissolving chloro-mekenic acid in strong ammonia. The solution soon becomes light red, dark red, violet, and finally intense dark blue, with a faint reddish fluorescence by reflected light. After standing for twenty-four hours it is acidified with hydrochloric acid, when the blue colour passes into a deep red. At the same time a fine precipitate falls, which, when dry, appears as a blue-black powder, and when pressed with a glass rod takes a green metallic lustre. This powder dissolves with difficulty in water, but very readily in dilute alkalis and in ammonia with an intense and splendid blue colour. The smallest particle of this substance gives a beautiful blue colour to a litre of water, which has been rendered slightly alkaline. On boiling the alkaline solution this blue colour passes into a violet and finally becomes colourless. Meken-blue is nitrogenous and is perfectly insoluble in alcohol, ether, chloroform, and benzol. From alkaline solutions it is precipitated unchanged. If the hydrochloric filtrate from meken-blue is repeatedly shaken out with ether, on the evaporation of the ether there remains meken-red as a deep red nitrogenous powder, sparingly soluble in alcohol, but readily in dilute acids with a fine red colour. Under the burnisher it assumes a lustre like cantharides.

On Oxykomazine.—Franz Krippendorff.—A voluminous paper, incapable of useful abstraction.

Contributions to a Knowledge of the Nitrogenous Derivatives of Comenic Acid.—E. Mennel.—The author's experiments prove that the nitrogenous derivatives of meconic and chelidonic acid are similarly constituted to the derivatives of cumalinic acid obtained by Von Pechmann.

Behaviour of Silver Cyanide with Sulphurous Chloride.—R. Schneider.—The products of the reaction are on the one hand silver chloride, and on the other disulpho-cyanogen, which is quickly resolved into mono- and tri-sulphocyanogen. The last mentioned compound is insoluble, and resembles in some respects the so-called pseudo-sulphocyanogen, but differs from it in composition. From persulphocyanic acid it differs both in its properties and by containing no hydrogen.

Remarks on the Foregoing Memoir.—E. von Meyer.—An editorial note confirming the view of Dr. Schneider that the product of the decomposition of trisulphocyanogen is tricyanuramide.

Researches on the Relations of Equilibrium in Aqueous Solutions.—Th. Thomsen.—The optical examination of mixed solutions of very different composition shows that the dissolved substances share the water among themselves in the proportion of their quantities, forming thus solutions of equal strengths. This result is so simple that it probably follows from a general law. The presence of certain hydrates in aqueous solutions may be demonstrated, and the quantity of water in chemical combination may be calculated by ascertaining the influence of the substance in question upon the specific rotatory power of tartaric acid dissolved in water.

On Sodium Fulminate.—Alex. Ehrenberg.—This salt is resolved on electrolysis in the first place into acid and base. The acid is then decomposed at the anode by the action of water and oxygen. The appearance of hydrocyanic acid as an oxidation-product of fulminic acid can be easily reconciled with the assumption of the presence of oximide. The occurrence of nitrogen monoxide may be attributed to the intermediate formation of hydroxylamine.

The Combustion of Gases in Elementary Analysis.—Alex. Ehrenburg.—This paper cannot be reproduced without the accompanying illustration.

On Phenyl-paramide.—B. Hotte.—The author has experimented on the behaviour of substituted ammonias

with mellitic acid at elevated temperatures. If 1 mol. mellitic acid and 6 mols. aniline were heated together to 160° in a closed tube for six to seven hours the product was found to be phenyl-paramide.

Experiments on Nitromethane.—A. Pfungst.—A preliminary notice on the behaviour of dichlorhydrine with nitro-methan.

On a Dimethyl-toluquinoline.—W. Pfitzinger.—This base is obtained by treating a mixture of acetone, paraldehyde, and paratoluidine with hydrochloric acid. It is a solid, melting at 63° and boiling at 277° to 278°. The author describes the picrate, dichromate, and hydrochlorate.

Journal de Pharmacie et de Chemie.

Series 5, Vol. xii., No. 8, October 15, 1885.

International Pharmaceutical Congress of Brussels.—At this Congress it was voted desirable that the legislation relative to the adulteration of foods and drinks, as also its penal sanction and the execution of the law, should be made the subject of an International agreement. The following conclusions were adopted concerning potable water:—

1. It should be limpid, transparent, colourless, inodorous, and free from suspended matter.
2. It should be cool, of agreeable taste; its temperature ought not to vary sensibly, and should not exceed 15°.
3. It should be aerated, and hold in solution a certain quantity of carbonic acid. The air which it contains should be more oxygenated than atmospheric air.
4. The quantity of organic matter, estimated as oxalic acid, should not exceed 20 m.grms. per litre.
5. The nitrogenous matter determined by means of alkaline permanganate (Wanklyn and Chapman's process) should not exceed 1-10th m.grm. albumenoid ammonia per litre.
6. It should not contain more than $\frac{1}{2}$ m.grm. ammonia per litre.
7. A litre of water should not contain more than $\frac{1}{2}$ grm. of mineral salts.
8. It should contain neither nitrites, hydrogen sulphide, sulphides, nor metallic salts precipitable by sulphuretted hydrogen or ammonium sulphide, with the exception of traces of iron, aluminium, or manganese.
9. It should not assume a bad smell on keeping, whether in an open or a closed vessel.
10. It should contain neither *Saprophytes*, nor *Leptothrix*, nor *Leptomites*, nor *Hyphothrix*, or other white Algæ; nor Infusoria, nor Bacteria, nor especially any of these beings in course of decomposition.
11. The addition of pure white sugar must not cause a development of fungus.
12. If cultivated with gelatin it must not produce Bacteria liquefying the gelatin in less than eight days.

Reactions of Selenious Acid with Sulphuretted Hydrogen, and of Sulphurous Acid with Seleniuretted Hydrogen.—E. Divers and Tetsukichi Schmidzu.—From the *Journal of the Chemical Society*.

Bleaching Oils.—M. Pasher.—From the *Chemist and Druggist*.

Determination of Free Sulphuric Acid in Vinegar.—M. Kohnstein.—From the *Chemist and Druggist*.

Oleomargarine.—From the *Chemist and Druggist*.

Zeitschrift für Analytische Chemie.

Vol. xxiv., Part 4, 1885.

Alcohol and Mixtures of Alcohol and Water.—Dr. G. Th. Gerlach.—A voluminous treatise extending to 46 pp., and incapable of extraction.

Moisture retained in Gases dried over Sulphuric Acid.—E. W. Morley.—A translation from an English work.

A New Method for the Determination of Alumina.—Dr. K. J. Bayer.—Inserted in full.

On Raisin Wines.—F. Schaffer.—These wines contain a relatively high percentage of sugar. In many cases there is an abnormal proportion of chlorides from impure well-waters. Calcium and magnesium are also found in abnormal quantities, and iron is generally abundant. Free tartaric acid is rarely present to any considerable extent.

Transferrer for Currents of Gases or Liquids.—E. Obach.—The description of this apparatus for turning currents of gases or liquids in different directions at pleasure requires the accompanying seven figures.

Electrolytic Separation of Zinc from Cadmium.—S. Eliasburg.—This paper will be inserted in full.

Uranium Acetate as a Reagent for Albumenoid Bodies.—M. Kowalewsky.—This paper also will be inserted at some length.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Algin.—Can any of your readers inform me where the new chemical product "Algin" can be obtained?—E. B.

Oil of Rhodium.—(Reply to "Normal Cyanide, F.C.S.")—An oil obtained by distillation from *Levant Lignum rhodium*, the root of Canary rosewood (*Genista Canariensis*). 80 pounds yield from 1 to 2 fluid ounces. Colour of the oil light yellow, growing red by keeping. It is imported from the Levant.—G. A. KEYWORTH, Hastings.

Charcoal Pastilles.—(Reply to "F. W.")—Powdered sandal-wood, 3 ozs.; styrax, 4 ozs.; benzoin, 3 ozs.; olibanum, 6 ozs.; cascarilla, 6 ozs.; Peruvian balsam, $\frac{1}{2}$ oz.; myrrh, $1\frac{1}{2}$ ozs.; nitre, $1\frac{1}{2}$ ozs.; oil of cinnamon, 20 drops; oil of cloves, 30 drops; otto of roses, 30 drops; oil of lavender, $1\frac{1}{2}$ drachms; balsam of tolu, $1\frac{1}{2}$ ozs.; camphor, $\frac{1}{2}$ oz.; charcoal, 3 lbs. Reduce all the solids to fine powder; mix all together and beat into a paste with mucilage of gum tragacanth; form into conical pastilles, and dry.—G. A. K.

MEETINGS FOR THE WEEK.

MONDAY, 21st.—Medical, 8.30.

London Institution, 5.

TUESDAY, 22nd.—Institution of Civil Engineers, 8.

ST. PAUL'S SCHOOL.—An Examination for filling up about Six Vacancies on the Foundation will be held on the 14th January, 1886.—For information apply to the Bursar, St. Paul's School, West Kensington.

TO MANUFACTURING CHEMISTS AND OTHERS.

The Metropolitan Board of Works will meet at the Office of the Board, Spring Gardens, S.W., on FRIDAY, the 8th day of JANUARY, 1886, at Twelve o'clock at noon precisely, and will then be prepared to OPEN TENDERS by parties who may be willing to contract for the supply of 2000 tons of Manganate of Soda, 1000 tons of Sulphuric Acid, and 100 tons of Caustic Soda. Parties desirous to submit Tenders for the whole, or any part, of the foregoing quantities, may obtain a copy of the Specifications, and information as to the periods and places of delivery, on application to the Chemist of the Board, at the Office, Spring Gardens, between the hours of nine a.m. and four p.m. (or on Saturdays between the hours of nine a.m. and two p.m.), until Thursday, the 7th day of January, 1886. The tenders, addressed to the Clerk of the Board, are to be delivered at the Office before four o'clock on the last-mentioned day, and no tender will be received after that hour. The parties tendering must be in attendance at the Board at twelve o'clock on the day appointed for opening tenders.

The Board do not bind themselves to accept the lowest or any tender.

J. E. WAKEFIELD,

Clerk to the Board.

Spring Gardens, S.W., 14th December, 1885.



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THE CHEMICAL NEWS.

VOL. LII. No. 1361.

A VOLUMETRIC METHOD FOR THE DETERMINATION OF ALUMINA.

By R. W. ATKINSON, B.Sc.

THE method of estimating alumina proposed by Dr. K. J. Bayer in the current issue of the *Zeitschrift für Analytische Chemie*, an abridged translation of which appeared in the CHEMICAL NEWS, vol. lii., p. 277, was foreshadowed two and a half years ago in a paper by Mr. Robert T. Thomson (CHEMICAL NEWS, vol. xlvii., p. 135), on the use of various substances as indicators in volumetric analysis. In paragraph twelve, on the effect of alumina, that writer actually calculates the amount of alumina found in his experiment, without, however, suggesting the application of the method for that purpose. At the conclusion of his paper (*Loc. cit.*, vol. xlix., p. 121) he states that experiments were made "with the view of basing a process for the determination of boric acid in borates on the difference of indication shown by phenol-phthalein and methyl-orange." These, however, ended in failures owing to the indistinct end reaction with the former indicator. The principle, therefore, of Bayer's method is not new, and I propose to confine the few notes I wish to make to a consideration of the exactness with which the alumina can be determined.

The process depends upon the fact that whilst sulphate of alumina is acid to litmus it is neutral to tropæoline; hence with the former indicator reddening occurs as soon as the whole of the alumina in alkaline solution is set free from combination with the alkali. With tropæoline, however, the alumina thus separated must be completely dissolved before the liquid will permanently give the acid indication, and the difference between the amount of acid used in the two cases is equivalent to the amount of alumina present in the solution; it is, in fact, the quantity of acid used to combine with and dissolve the alumina set free by the neutralisation of the alkali with which it was previously combined.

Now the question arises whether these two points are sufficiently well-defined to serve for the exact estimation of the alumina, and anyone who tries the experiment in the form indicated by Dr. Bayer will come to the conclusion that it is not so. With litmus it is necessary to use from $\frac{1}{10}$ c.c. to $\frac{3}{10}$ c.c. of normal acid in excess to arrive at the neutral tint, and the results so obtained are consequently below the truth. To avoid this source of error I substituted phenol-phthalein as the indicator in place of litmus, and found it to answer admirably, as its change of colour is very much sharper than that of litmus.

The second source of difficulty lay in deciding upon the end reaction with tropæoline as indicator, inasmuch as towards the end the alumina dissolves only slowly, and if the first reddening of the solution which appears to be lasting be taken the results obtained will be too low. It is, therefore, necessary to allow the solution to remain for two or three minutes with frequent stirring between each addition of the acid. In order to be quite certain of the end point it is necessary to use a similar quantity of alkaline solution tinged with the same volume of tropæoline solution for comparison, as Dr. Bayer recommends for "inexperienced persons." The difference in tint (unless a marked excess of acid be used) which indicates the complete solution of the alumina is so faint that without using the standard tint for comparison an excess of acid amounting to two- or three-tenths of a cubic centimetre might be used, the results then being correspondingly low.

We may readily calculate the efficiency of the method by assuming that $\frac{1}{10}$ c.c. of normal acid in excess was used, the weight of alum taken being that given by Dr. Bayer. In each experiment he used 100 c.c. of solution containing 0.9154 grm. alum, and the difference between the titrations amounted to 5.55 c.c. of normal sulphuric acid, equivalent to 0.09435 grm. Al_2O_3 , or 10.31 per cent.

If 5.65 c.c. had been used, the alumina corresponding would have been 0.09605 grm., equal to 10.49 per cent. Thus a difference of $\frac{1}{10}$ c.c., using 0.9 grm. alum, means a variation of 0.18 per cent. It is not possible to be absolutely sure of the result to within $\frac{1}{10}$ c.c., and the error of the process is therefore, under the stated conditions, about two-tenths of one per cent—for manufacturing purposes, quite as near as is ever required.

I may conclude by giving some results obtained by using litmus on the one hand, and phenol-phthalein on the other in the determination of the alumina in ammonia alum.

With Litmus.

	Alum used.	Sulphuric acid (difference between titrations).	Per cent Al_2O_3 .
1.	0.400	0.1263 grm.	10.95
2.	0.500	0.1554 "	10.78
3.	1.000	0.3108 "	10.79

With Phenol-phthalein.

4.	0.3998	0.12992 grm.	11.28
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Whilst all the experiments in which litmus was used as indicator fall markedly below the theoretical percentage, viz., 11.20 p.c., that found with phenol-phthalein as indicator is slightly higher than the result obtained by a gravimetric determination, which was 11.24 p.c.

44, Loudoun Square, Cardiff.
December 7, 1885.

THE DETERMINATION OF POTASSIUM TARTRATE IN CRUDE ARGOLS AND WINE-LEES.

By F. KLEIN.

THESE raw materials are classified as those which are rich in calcium tartrate and poor in potassium bitartrate, and those rich in bitartrate and poor in calcium tartrate. The former are consumed chiefly in the manufacture of tartaric acid; the latter in tartar-refineries, manufactories of tartar-emetic and salts of Seignette, dye-works, &c.

Almost all transactions in the raw materials are effected on the basis of a guaranteed percentage. The proportion of valuable materials is effected by different methods, according to their source or the purpose in view. The methods are—

- The Volumetric Process.
- The "Méthode à la Cassarole."
- The Determination of Total Acidity.
- The Determination of Effective Tartar.

The first of these methods, the volumetric analysis, is used up and down in the argol trade, especially in Germany, Austria, Tuscany, and Spain. The second, or pan analysis, is employed in all transactions on French account, whether in France, Italy, or Spain. The third and fourth methods have their seat in Sicily. All the raw materials exported from that island are sold according to these methods. It is to be remarked that none of these methods, taken singly, gives the technical chemist a clear view of the composition of a raw argol or wine-lees, a combination of three of them being necessary.

Volumetric Analysis.—Concerning the execution of this process there is no need of remarks, but as regards its practical value there is room for caution.

In all the tartaric raw materials there are other substances having an acid reaction. By the volumetric process all such substances are determined and calculated as tartar, so that this method always gives the proportion of potassium bitartrate too high. On the other hand, the calcium tartrate which is always present is totally disregarded. If employed alone this process is not merely quite worthless, as it does not give the information needed, either in purchasing or in the technical utilisation of the materials, but it is also unsafe, as several refined methods of fraud have been adapted to it, such as the adulteration of argols with alkaline bisulphates, or with potassium acid oxalate. It can only be considered of value if used along with the determination of total acid and of bitartrate to show the apparent proportion of tartar.

Of more value, at least from the practical point of view of the refiner, is the second method, *Pan Analysis*, on the French system, the "méthode à la casserole" of Prof. Röhrig, of Bordeaux. Its purpose is simply to inform the manufacturer of refined tartar the yield which he may expect from a given sample. Such a method of determination, though not very exact from a theoretical point of view, has often valuable properties for the manufacturer who is accustomed to it, and is accustomed to carry it out with diligence and knowledge of the subject. Fifty grms. of coarsely-ground argol are boiled for ten minutes in 1 litre of water; the solution is decanted off (leaving all insoluble matters at the bottom), and is then left for twelve hours at the common temperature to crystallise. Thereupon the crystals are washed in cold water, the washings poured carefully off, and allowed to dry. The number of grammes found, multiplied by 2, and with the addition of 10 "degrees" which are supposed to be lost in the washing-water, give the "degree" of the ware on the French system, so called because all French consumers regulate their purchases according to this analysis.

The third method, the *Total Tartaric Acid* determination, is chiefly applied in determining the proportion in raw argols and lees, poor in bitartrate but rich in calcium tartrate, as used in the manufacture of tartaric acid. It purposes to give the tartaric acid manufacturer a view of the yield to be expected from any raw material. It serves, in combination with the volumetric analysis and the bitartrate method, to resolve the material in question into its proximate constituents. This method is carried out in different manners.

According to A. Scheurer-Kestner and Fr. Dotte Scribani, the argol or lees is treated with hydrochloric acid, filtered, neutralised with caustic soda, and precipitated by calcium chloride; the precipitate is washed, burnt, and titrated.

According to another modification the raw material is boiled out with potassium carbonate, and the neutralised filtrate is decomposed with calcium chloride. These methods turn on combining the tartaric acid existing in the raw material with calcium, and determining the total tartaric acid from the calcium tartrate precipitated.

L. Weigert, G. Kämmer, and others describe a process in which the raw material is decomposed with potassium carbonate, the neutral potassium tartrate is converted by bitartrate, by acetic acid, and the latter separated out by means of alcohol.

Warington and B. J. Grosjean have developed a method, the so-called oxalic acid method, the principles of which are as follows:—Neutralise the crude argol or the lees, decompose the existing lime-salts with potassium oxalate, and precipitate bitartrate from the neutral potassium tartrate by means of an excess of citric acid. These two latter modifications aim at fixing and determining the total tartaric acid present in the form of the characteristic bitartrate.

The author has for a long time employed Warington's process for determining total acid in crude argols and lees, and proceeds as follows:—

A quantity of the sample in question is weighed off,

such as may contain 1.8 to 2.2 grms. of potassium bitartrate. It is accurately neutralised (titrated) mixed with 3 grms. of potassium oxalate, heated for half an hour on the water-bath, filtered when cold, and washed.

The filtrate and washing waters are evaporated down to about 40 c.c., mixed when cold with 5 grms. potassium chloride and 3 c.c. of a 50 per cent solution of citric acid, and stirred for fifteen minutes and let stand over night. It is filtered, and washed with a 10 per cent solution of potassium chloride which has been previously saturated with pure bitartrate at common temperatures until a drop of the filtrate produces the same redness upon a broad slip of litmus-paper as a drop of the wash-liquid itself. Thereupon the filter and precipitate are taken from the funnel, and titrated with semi-normal potassa or soda. The results are satisfactory; they are rather more accurate when the mixture has been stirred than when it has been let stand.

The Analysis of Effective Tartar: Bitartrate Determination aims at the determining the proportion of pure acid tartrate.

It is of extraordinary importance for the producer of tartariferous raw material, who has to classify his product accordingly. Of two lots which contain the same quantity of total acid, that one fetches the higher figure which in proportion to a certain quantity of potassium bitartrate contains but little calcium tartrate. This applies especially to wine-lees: those containing a predominating proportion of calcium tartrate are sold according to the total proportion of acid. Those with a predominating quantity of potassium bitartrate are sold according to the percentage of bitartrate.

This method is equally suitable for all those branches of manufacture in which the proportion of actual bitartrate plays the main part, for it shows directly the real proportion of this essential constituent, and in conjunction with the 1st and 3rd methods, an accurate insight into the composition of the sample in all directions.

In carrying out the determination of the effective tartar, the author required a satisfactory process giving exact results. He made the attempt to utilise the insolubility of potassium bitartrate in a solution of potassium chloride for separating and washing the potassium bitartrate extracted from any raw material. He sought for an indifferent precipitant which should have no transforming influence upon the other acid constituents existing in the mother-liquor from which the bitartrate has crystallised out. To establish the method he carried out the following normal determinations:—

Of a pure argol, containing 99.87 actual potassium bitartrate, 1.969 grms. was weighed off, and dissolved in hot distilled water. The solution was evaporated down to 40 c.c.; to the solution were added 5 grms. potassium chloride, stirred for a short time, and let stand over night. The next morning the precipitate was placed on a filter which had been previously moistened with the washing-liquid. The washing-liquid is prepared as follows:—In a $\frac{1}{4}$ -litre flask are put about 5 grms. of pure, finely-powdered argol and 200 c.c. of distilled water: after shaking, 25 grms. of potassium chloride were added, and the flask filled up to the mark with water. After standing for several hours, with frequent shaking, the solution may be filtered off for use.

The precipitate of potassium bitartrate on the filter was washed with 15 c.c. of this liquid, introduced into the capsule along with the filter, heated with distilled water, and titrated. As indicator is used a solution of phenol phthaleine. The titration showed 99.60 potassium bitartrate instead of 99.87.

Two more portions of the same argol were weighed off and treated as above, with the sole difference that the mass mixed with calcium chloride was not let stand twelve hours, but was immediately—after mixing with calcium chloride—stirred violently for fifteen minutes with a glass rod. The titration gave (a) 99.80, (b) 99.84 instead of 99.87 per cent. It appears that the results, on

violent stirring and filtering at once, are higher than on filtration on standing for twelve hours without prolonged standing. From these experiments it appears that this method gives results satisfactory for practical purposes.

It was further necessary to ascertain what influence the presence of other salts might have upon the result of the experiment.

The author mixed 1.875 of the above tartar with 0.625 of pure calcium tartrate, and added a quantity of acid potassium phosphate. The mixture was boiled, the filtrate evaporated down as above, according to the method of "letting stand," but a 5 per cent solution of potassium chloride was used instead of one at 10 per cent. The titration gave 99.52 per cent of potassium bitartrate. The presence of 25 per cent calcium tartrate, and its equivalent of acid calcium phosphate, forms no hindrance to the application of this process.

A further experiment was made with 5.589 grms. of a wine-lees (containing 34.04 per cent of effective argol, 6.27 per cent of crystalline calcium tartrate, and 1.77 per cent of nominal tartar), exhausted with water; the filtrate was concentrated to 40 c.c., mixed with 5 grms. calcium chloride, and stirred violently for fifteen minutes. The mother-liquor was filtered off from the precipitate by bitartrate, mixed with 2.178 grms. of the 99.87 per cent tartar, slightly diluted, boiled, concentrated to 40 c.c., and left to stand for twelve hours. After washing with 10 per cent solution of potassium chloride it gave, on titration, 99.76 per cent of potassium bitartrate. Hence the author considers that this method may be safely applied to the technical determination of the proportion of effective potassium bitartrate in raw tartariferous products.—*Zeitschrift für Analyt. Chemie.*

THE SEPARATION OF THE CINCHONA ALKALOIDS.

By Y. SHIMOYAMA.

FOR the determining the quinine in the mixture of alkaloids obtained by extraction the author places at least 0.5 gm. in a beaker, and dissolves it at a very gentle heat by the addition of a minimum of very dilute acetic acid in 30 to 40 c.c. of water. When the solution is cold it is filtered into a tared beaker, the filter carefully washed, and the filtrate neutralised with a very dilute soda-lye. If any insoluble substance separates out, the liquid is filtered through the smallest possible filter, and the filtrate is mixed with a suitable proportion of a solution of sodium oxalate saturated at 18°. One c.c. is required for every 0.1 gm. of the mixture of alkaloids taken for analysis. The liquid is evaporated on the water-bath down to 8 to 10 grms., until a distinct separation takes place on cooling. From 10 to 15 c.c. of water are then added to the contents of the beaker, and the whole is stirred until the smeary mass which separated out along with the precipitate of oxalate is completely dissolved. The beaker is then set aside for three hours at 18°, stirring frequently. The weight of the contents of the beaker is determined, the precipitate is filtered upon a double filter, washed several times, with the aid of a filter-pump, with a solution of quinine oxalate saturated at 18°, rinsed with 50 c.c. of a saturated solution of quinine oxalate into a capacious flask, well shaken for 15 to 20 minutes, and set aside for two hours at 18°, shaking from time to time. The precipitate is collected upon a double filter, which has been dried at 110°, and weighed and washed with a saturated solution of quinine oxalate, using a filter-pump. The moist filter with the precipitate is weighed between watch-glasses to ascertain the quantity of the saturated solution of quinine oxalate contained in it, dried for three hours and weighed again. If for every gm. of the difference of weight ascertained (quantity of water of the saturated solution of quinine oxalate) we deduct 0.00069

gm. from the obtained quantity of dry quinine oxalate we obtain the quantity of the precipitated quinine oxalate. If the latter is subtracted from the ascertained weight of the contents of the beaker we find the weight of the mother-liquor. By multiplying its weight in grms. with 0.00064, we obtain the quantity of the quinine oxalate which remains in solution in the mother-liquor, which must then be added as a correction to the weight of the separated salt. 1 gm. quinine oxalate represents 0.878 gm. quinine. In the determination the above-mentioned temperature must be carefully adhered to, as even small fluctuations of heat produce considerable differences in the results. If the total quantity of the alkaloids contains only 20 per cent of quinine the separation of the oxalate sometimes only begins after two to three hours. For the complete separation of the quinine oxalate it is important to stir the liquid frequently. If the quinine is less than 20 per cent of the total alkaloids this method is not applicable.—*Archive der Pharmacie and Zeitschrift für Analyt. Chemie.*

SEPARATION OF ZINC FROM ALL THE METALS OF ITS GROUP.

By W. HAMPE.

FOR separating zinc from iron, nickel, cobalt, manganese, and aluminium, the author recommends the conversion of the metals into formiates, and the treatment of the solution with sulphuretted hydrogen. Whilst the zinc is completely precipitated, manganese and aluminium, nickel, cobalt, and iron, are said not to be thrown down provided that the solution contains a sufficiency of free formic acid (at least 15 to 20 c.c. of acid at 1.2 sp. gr. to 250 to 500 c.c. of liquid), and that such metals are not present in too large quantity. Otherwise traces of foreign sulphides accompany the zinc sulphide, and their presence may be easily known by the reddish-brown colour of the precipitate. Iron falls most easily in this method, nickel and cobalt less readily. These impurities are quantitatively very trifling. For their entire removal the filtered and washed precipitate is dissolved in nitric acid, supersaturated with ammonia, then with formic acid, and finally re-precipitated with hydrogen sulphide. Such a repetition of the precipitation—though by no means invariably necessary—would deprive this method of its chief advantages if there were not a means of making the zinc-sulphide capable of rapid and easy filtration. To this end Hampe passes hydrogen sulphide into the hot solution, zinc sulphide is then deposited as a granular sulphide, which admits of rapid and clear filtration and washing. As washing-liquid he uses sulphuretted hydrogen water, to which have been added a little ammonium formiate and formic acid:

On passing hydrogen sulphide into the hot solution a little zinc sulphide—perhaps 1 milligram—is deposited so firmly on the side of the beaker that it cannot be rubbed off. After rinsing out the glass this film is dissolved in a little nitric acid, and the solution is joined to the main quantity if the precipitation is to be repeated. If this is not necessary the nitric solution of that film is mixed with ammonia and ammonium sulphide, and formic acid is then added until the reaction is acid. The mixture is then poured upon the washed precipitate on the filter.

When dry the zinc sulphide is not horny and brittle, like that precipitated from an acetic solution, but pulverulent. Hence it can easily be detached from the filter without fear of loss.—*Chemiker Zeitung and Zeitschrift f. Anal. Chemie.*

Action of Chlorine upon Anhydrous Chloral.—H. Gautier.—The liquid product of the reaction is carbon tetrachloride. The gaseous products are hydrochloric acid and carbonyl chloride.—*Comptes Rendus, ci., No. 23.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING NOVEMBER 30TH, 1885.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner,
Metropolis Water Act, 1871.*

London, December 7th, 1885.

SIR,—We submit herewith the results of our analyses of the 175 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from October 1st to October 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in all the samples submitted to analysis.

Of the 175 samples examined, two were recorded as "very slightly turbid" and one as "slightly turbid;" excepting these, the whole were found to be perfectly clear, bright, and well-filtered.

Almost throughout the month of November the river was in a state of high flood, and with this condition there was an appreciable proportionate increase in the amount of organic matter present in the water supply. The absolute increase was, however, very small; the mean amount of organic matter in the Thames-derived supply for November being in excess of the exceptionally small amount present in the supply for October by about the one-sixteenth part of a grain per gallon.

The subject of micro-organisms in water has been under our attention and experimental investigation for some time past. Speaking of reports made on the examination of the metropolitan water supply by Dr. Koch's gelatin method, you, Sir Francis Bolton, and Dr. Percy Frankland very properly observe:—"Any public alarm which the misapprehension of our reports may have caused will doubtless be allayed by a consideration of the fact that micro-organisms are not only present in nearly all natural waters, but that they are inhaled by every inspiration from the air."

We are, Sir,
Your obedient Servants,

WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

On Certain Properties of Zinc.—L. L'Hôte.—The author undertook to inquire if zinc free from any foreign metals decomposes water either on boiling or in presence of dilute sulphuric acid. Experiment proved that such is not the case. Pure zinc heated with distilled water in a flask, so arranged as to receive the gases over mercury, gave off no hydrogen on prolonged boiling. It was also not attacked by dilute sulphuric acid. The presence of iron in proportions of from 3 to 5 in 100,000 enabled it to decompose water. Traces of arsenic and antimony have the same effect.—*Comptes Rendus*, vol. ci., No. 23.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 17th, 1885.

Dr. HUGO MÜLLER, F.R.S., President, in the Chair.

MESSRS. W. Dalrymple Borland, James Epps, jun., Lazarus Fletcher, and Lewis Gordon Paul, were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Henry Kelway George Bamber, 5, Westminster Chambers, S.W.; Adolph Dressel, 1, Marlow Road, Anerley, S.E.; Herbert Samuel Ebworthy, Rosa, North West Provinces, India; Bertram Harvey Hart, The Elms, Old Charlton, Kent; George Thomas Holloway, 17, Bridge Road, West Battersea; Eugene Obach, 2, Victoria Road, Old Charlton, Kent; Oliver Quibell, Highfield, Newark; Richard Spencer, Holker Street, Barrow-in-Furness.

The following were elected Fellows of the Society:—Messrs. Robert G. Christopher, William J. Cousins, Andrew Thomson, William Watson Will, William Matthew Wilson.

The following circular letter was read by the Secretary:—

ELIZABETH THOMPSON SCIENCE FUND.

This fund, which has been established by Mrs. Elizabeth Thompson, of Stamford, Connecticut, "for the advancement and prosecution of scientific research in its broadest sense, now amounts to 25,000 dollars. As the income is already available, the trustees desire to receive applications for appropriations in aid of scientific work. This endowment is not for the benefit of any one department of science, but it is the intention of the trustees to give the preference to those investigations, *not already otherwise provided for*, which have for their object the advancement of human knowledge, or the benefit of mankind in general, rather than to researches directed to the solution of questions of merely local importance.

Applications for assistance from this fund should be accompanied by a full statement of the nature of the investigation, of the conditions under which it is to be prosecuted, and of the manner in which the appropriation asked for is to be expended. The applications should be forwarded to the Secretary of the Board of Trustees, Dr. C. S. Minot, 25, Mt. Vernon Street, Boston, Mass., U.S.A.

The first grant will probably be made early in January, 1886.

(Signed) H. P. BOWDITCH, *President.*
WM. MINOT, JR., *Treasurer.*
FRANCIS A. WALKER.
EDW. C. PICKERING.
CHARLES SEDGWICK MINOT, *Secretary.*

The following papers were read:—

78. "The Action of Steam on Carbonic Oxide." By H. B. DIXON.

The action of steam in determining the union of carbonic oxide and oxygen has been explained by the author as leading to an alternate reduction and oxidation whereby the hydrogen conveys the oxygen to the carbonic oxide:—(1) $\text{CO} + \text{H}_2\text{O} = \text{CO}_2 + \text{H}_2$; (2) $2\text{H}_2 + \text{O}_2 = 2\text{H}_2\text{O}$. This explanation has been rejected by Moritz Traube (*Ber.*, 1885, p. 1890) on the ground that carbonic oxide does not decompose steam at a high temperature. Traube represents the influence of steam as consisting in the formation from it of peroxide of hydrogen, which oxidises carbonic oxide, steam being re-formed.

The author has already shown that steam is decomposed by carbonic oxide at a high temperature, for when carbonic oxide is exploded in presence of steam with insufficient oxygen to completely burn it, the carbon dioxide formed is more than double the oxygen, and hydro-

gen is found in the residue. Horstmann arrived at the same conclusion.

When sparks are passed through a mixture of steam and carbonic oxide, carbon dioxide and hydrogen are formed until a certain fraction (which varies with the nature of the spark) of the carbonic oxide is turned into carbon dioxide.

When sparks are passed through a mixture of carbon dioxide and hydrogen, carbonic oxide and steam are formed until a certain fraction of the carbon dioxide is turned into carbonic oxide.

In neither case is the reaction complete. An equilibrium is reached when about 10 per cent of carbon dioxide is present to 90 of carbonic oxide.

By the prolonged passage of the sparks a considerable quantity of formic acid is produced.

When a coil of platinum wire is heated to redness in steam and carbonic oxide, carbon dioxide and hydrogen are formed until from 10 to 15 per cent. of the carbonic oxide has been oxidised. Similarly, when a coil of platinum wire is heated in carbon dioxide and hydrogen, carbonic oxide and steam are formed until the corresponding limit is reached. No formic acid is produced. When a coil of wire is maintained at a red heat in a mixture of carbonic oxide and steam, and the carbon dioxide formed is removed by means of a dilute solution of potash, the carbonic oxide is in time completely oxidised to carbon dioxide with the liberation of the corresponding volume of hydrogen. Similarly, when a coil of platinum wire is maintained at a red heat in a mixture of carbon monoxide and hydrogen, and the steam formed is removed by means of phosphoric oxide, the carbon dioxide is in time completely reduced to carbonic oxide.

Since these experiments were made Naumann has shown that when carbonic oxide and steam are heated in a tube to 950°, 10·5 per cent of carbonic oxide is turned into carbon dioxide.

79. "*On Multiple Sulphates.*" By Miss E. ASTON and S. U. PICKERING.

Double salts of the type $M''SO_4 \cdot K_2SO_4 \cdot 6H_2O$ are stated by Vohl to be capable of combining with each other in definite proportions, forming "double-, triple-, or quadruple-double sulphates."

By mixing the constituents in various proportions the authors have found that no definite salts can be obtained, but that a constant variation in the composition of the product results from a variation in the proportion of the salts taken. These results were obtained whether the solutions were mixed in the cold, whether hot solutions were allowed to crystallise by cooling, or whether the solutions were left to evaporate spontaneously.

The potassium-magnesium-copper sulphate and the potassium-cobalt-copper sulphate were the two salts belonging to the first-mentioned class which were examined. In the second class the cases examined were copper-magnesium sulphate and cobalt-magnesium sulphate. With the former of these there even appears to be a strong disinclination to crystallise in a proportion in any way approaching to an equal number of molecules of the constituent sulphates.

The only argument in favour of the existence of these salts must be that with those which contain potassium the copper salt carries down with it a certain quantity of the magnesium salt, even from a solution too dilute to yield this latter of its own accord; and, with those which do not contain potassium, that an excess of either the copper or the magnesium sulphate will induce the other to crystallise out in a form and with a proportion of water foreign to its nature. That such salts, however, can be ranked with definite compounds is impossible.

DISCUSSION.

Mr. J. M. THOMSON agreed with Mr. Pickering that the salts in question were compounds of a very indefinite nature. In a paper published in the British Association Report for 1877, he, however, had pointed out that in the

case of the double sulphates of potassium and nickel or cobalt, if the crystallisation take place spontaneously or at temperatures below 80°, a regular displacement of each other by the nickel and cobalt is observed: the water, SO_4 , and potassium remaining constant in the several fractions. Instead, however, of the simple formula $(M''M'')K_4(SO_4)_4 \cdot 12H_2O$ given by Vohl, a much more complex formula, such as $24[M''M''K_4(SO_4)_4 \cdot 12H_2O]$, is required to express the relation between the two metals. The fractions are very distinctly dichroic, and when examined through the two opposite axes, a change of colour may be observed in successive fractions. This is also evidence of some state of association more definite than isomorphous mixture, as large crystals taken for analysis exhibited the same dichroism throughout.

80. "*On the Use of Ferrous Sulphate in Agriculture.*" By A. B. GRIFFITHS, Ph.D.

Wheat crops have been grown during the past season by the author with and without the addition of iron sulphate to the land ($\frac{1}{2}$ cwt. to the acre). The crop grown with iron sulphate yielded $32\frac{1}{2}$ bushels of grain, while that grown without yielded 30 bushels; hence it appears that iron sulphate is not such a good manure for cereals as for root and leguminous crops. On the other hand, a Mr. Edgson, of Etton, near Peterborough, has used iron sulphate with considerable benefit for wheat crops this year. It is stated that iron sulphate used as a top-dressing to grass-land destroys moss, and that the ashes of the dead moss contained 11·56 per cent. of iron oxide. The grass, on the other hand, grew well after the treatment, and the amount of ferric oxide in its ashes was only 2·46 per cent. It is also stated that a solution containing 0·1 gram of iron sulphate in 100 grams of water destroys *Peronospora infestans* and its spores; also the "wheat-mildew" and its spores.

In a series of experiments with potatoes, three plots of land of the same size were manured—B with iron sulphate and artificial manures, C with the artificial manure alone, and plot A was left normal. B gave a yield of $8\frac{1}{2}$ tons of tubers, C $6\frac{1}{2}$ tons, and A only 3 tons.

The best way to apply the sulphate to the land is as a top-dressing, the quantity being $\frac{1}{2}$ cwt. to the acre.

81. "*On Phenyltribromomethane, $C_6H_5 \cdot CBr_3$.*" By WALTER H. INCE.

The author describes a method of preparing this compound by adding bromine to boiling toluene in a specially constructed apparatus in which the use of corks and caoutchouc is avoided; he has also prepared it by passing the vapour of toluene into a flask filled with bromine vapour. It is a colourless, mobile liquid, soluble in alcohol, ether, benzene, and toluene; when heated above about 150° it decomposes, and cannot therefore be purified by distillation. It slowly decomposes on exposure to sunlight. Its vapour has a perfectly overpowering action on the eyes and mucous membranes. When heated with water it readily forms benzoic acid; but it is very slightly acted upon even after prolonged boiling with alcohol.

At the meeting on February 4th, Dr. Klein, F.R.S., will deliver a lecture on "Methods of bacteriological research from a biologist's point of view."

PHYSICAL SOCIETY.

December 12th, 1885.

Prof. GUTHRIE, President, in the Chair.

MR. C. F. Casella and Prof. T. E. Thorpe were elected Members of the Society.

The following papers were read:—

"*On a Magneto-electric Phenomenon.*" By G. H. WYATT.

The author had conducted a series of experiments with a view of testing experimentally an expression obtained

by Mr. Boys for the throw of a copper disc suspended by a torsion fibre between the poles of an electro-magnet when the current was made or broken, and communicated by him to the Society on June 28, 1884. Discs of various metals and of various dimensions were used, the results being such as to agree with the theory within narrow limits. It was, however, found that when the throw of the disc was used to measure the magnetic field, the value obtained from the throw at break was uniformly greater than that obtained on making the current.

Prof. S. P. THOMPSON observed that the case presented was analogous to that of the ballistic galvanometer, and that for the theory it was necessary that the magnetic field should be made and destroyed before the disc had moved sensibly.

Mr. Boys believed that the results of the experiments showed this to be the case, since the result of such a movement would be to increase the throw on breaking the current, when the disc made an angle of less than 45° with the lines of force, and to decrease it when the angle was between 45° and 90° , whereas no such variation from the theoretical result was observed.

"On some Thermodynamical Relations." By Prof. WILLIAM RAMSAY and Dr. SYDNEY YOUNG.

In this paper experimental proof is given of the following relations:—(1) The amount of heat required to produce unit increase of volume in the passage from the liquid to the gaseous state, at the boiling-point under normal pressure, is approximately constant for all bodies. (2) If these amounts of heat be compared at different pressures, for any two bodies, then the ratio of the amount at the boiling-point under a pressure p_1 to the amount at another pressure, p_2 , is approximately constant. (3) The products of the absolute temperature into the rate of increase of pressure with rise of temperature are approximately the same for all stable substances. (4) The rate of increase of this product with rise of pressure is nearly the same for all stable substances. (5) A relation exists between the absolute temperatures of all bodies, solid or liquid, stable or dissociable, which may be expressed in the case of any two bodies by the equation—

$$\frac{T_A}{T_B} = \frac{T_{A'}}{T_{B'}} + C(T_{A'} - T_A),$$

T_A and T_B being the absolute temperatures of the two bodies corresponding to any vapour-pressure. $T_{A'}$ and $T_{B'}$ absolute temperatures at any other pressure, and C a constant which may be zero or a small positive or negative quantity. (6) The variations from constancy of the expression $t \frac{dp}{dt}$, though small, may be expressed by a similar

equation. (7) If L_A , $L_{A'}$, L_B , and $L_{B'}$ represent similar relations of latent heats at different pressures the same for A and B , it appears probable that—

$$\frac{L_A}{L_{A'}} = \frac{L_B}{L_{B'}} + C(T_{A'} - T_A).$$

(8) The ratio of the heats of vapourisation of any two bodies at the same pressure is approximately the same as that of their absolute temperatures at that pressure. The authors conjecture that this statement is also true of dissociating bodies. A large part of the experimental work consisted in obtaining the relation between vapour-pressure and temperature of different substances. Values of $\frac{f \delta p}{\delta t}$

had been obtained from these observations in two ways, by plotting curves with t and p as co-ordinates and drawing tangents, and by the method of differences.

Prof. PERRY suggested that the curve should be expressed in such a form as—

$$\log. p = \alpha - \frac{\beta}{t} - \frac{\gamma}{t^2},$$

which Rankine has shown to be a very true expression for the relation between pressure and temperature, and

that $\frac{dp}{dt}$ should be obtained from this by differentiation.

Prof. GUTHRIE hoped the authors would experiment upon the vapour-tensions of mixed liquids, a subject to which he had himself given some attention.

NOTICES OF BOOKS.

The Prospector's Handbook: a Guide for the Prospector and Traveller in Search of Metal-Bearing and other Valuable Minerals. By J. W. ANDERSON, M.A., F.R.G.S. London: Crosby Lockwood and Co.

THE nature of this work is sufficiently evident from the title, and we may congratulate the author on having met what was certainly a distinct want. The bulk of the information here given was indeed to be found in geological, mineralogical, and chemical text-books, but it is impossible for the prospector to carry with him in his saddle-bags or his knapsack a library of reference, and if not impossible it is at least very inconvenient for him to search for the advice he wants among matter of doubtful relevance. Mr. Anderson has compressed the information which is most essential within very brief compass and has expressed it in very simple language. The first chapter is devoted to "prospecting" in general; the explorer is instructed where to look for indications of mineral wealth and how to recognise them when present. In the second chapter we have an account of rocks, of lamination, stratification, denudation, cleavage, joints, &c., a description of the conditions under which metalliferous deposits are found, of the nature of mineral veins in a lode. Lastly come directions for the use of the clinometer in determining the dip. The subject of chapter III. is the determination of minerals by the blowpipe. Here it becomes doubtful whether an operator who has not had some laboratory practice will find it practicable to reach decisive results by the instructions given. We should strongly advise all persons who contemplate an exploring journey to familiarise themselves with the use of this handy little instrument before setting out. Such persons will find the author's instructions a satisfactory *vade mecum*.

In chapter IV. we have a description of the external characters of minerals, such as specific gravity, hardness, and crystalline form.

In the fifth chapter the author reviews in alphabetical order the principal native metals and metallic ores, giving their characteristics and their occurrence, his chief attention being given to gold. No mention, however, is made of uranium and vanadium, which are both increasing in commercial importance.

In the sixth chapter we find a notice of "other useful minerals and ores." Here is no mention of bauxite and cryolite,—both very valuable in accessible localities—nor yet of native sulphur and selenium.

Chapter VII. is taken up with an account of the composition of the more important rocks, of the nature of certain minerals met with in igneous and metamorphic rocks, and of the principal matrices of veins.

A very brief chapter (VIII.) is devoted to the systematic testing of ores in the wet way, whilst chapter IX. gives a sketch of the quantitative examination of ores both in the dry and the wet way. Here again, as in the case of blowpipe analysis, but more strongly, we cannot help feeling very doubtful as to the sufficiency of the instructions given. We should feel very sceptical as to the results of an assay of gold or silver unless the operator had enjoyed a course of practical instruction.

With the tenth chapter the author leaves the chemical part of his subject and passes to the art of surveying.

An appendix contains tables of weights and measures; weights of rocks and ores per cubic foot; specific gravities

of metals (that of platinum being given as low as 16 to 19, which must doubtless refer to impure native specimens), of common ores met with in veins of gold and silver, and of metallic ores. Then follow tables of natural sines, of the melting-points of metals—that of mercury being given as 39° F.—the sign being omitted—and a list of useful books of reference. Then follows a glossary of the technical terms used in mining. When we remember that the entire work, the index included, only runs to 132 pages we can only wonder that the omissions have not been more numerous.

Handbook of Technical Gas Analysis, containing Concise Instructions for carrying out Gas-analytical Methods of Proved Utility. By CLEMENS WINKLER, Ph.D., Professor of Chemistry at the Freiberg Mining Academy. Translated, with a few additions, by GEORGE LUNGE, Ph.D., Professor of Technical Chemistry at the Federal Polytechnic School, Zurich. London: J. Van Voorst.

THE examination of gaseous mixtures has now become an important and necessary branch of technical analysis. Not alone coal-gas, but the gases of the lead chambers and those of blast-furnaces, require to be qualitatively and quantitatively determined, in order to keep up an intelligent oversight of the working of the various processes. The author remarks, in his Preface, that in Germany "every factory of any size is more or less provided with apparatus for gas analysis," and the translator informs us that in the same country it is usual to perform gas analyses not merely in chemical works, but, *e. g.*, for testing the efficiency of steam-boiler furnaces. In England this is not the case, at least only to a very limited extent. We are therefore strongly of opinion that Dr. Lunge, by preparing an English version of the work before us, has rendered an important service to English chemists and manufacturers.

Prof. Clemens Winkler holds a similar position with respect to gas analysis which Plattner takes in the use of the blowpipe, or Mohr in the volumetric analysis of liquids. Prior to him certain gas analytical processes were in use, but, as Dr. Lunge here remarks, "Winkler was the first to draw attention to the importance of this subject, to invent suitable apparatus, and to elaborate a complete system of technical gas analysis, qualitative and quantitative."

To two limitations in the scope of the work attention is expressly called. It does not attempt, like Prof. Winkler's earlier work (*"Anleitung zur Chemischen Untersuchung der Industrie-Gase"*), to enumerate every kind of apparatus which has been proposed for gas analysis. But, as Dr. Lunge remarks, "a person who has mastered the processes and apparatus described in this book will at once comprehend and manage any other gas analytical process or apparatus he may require for his special purpose."

Another limitation is that the scope and object of the treatise are purely technical. The methods employed in pure research, such as those where the gases are confined over mercury, find here no place.

In the "Introduction" we find the principle laid down that in technical gas analysis absolute accuracy is of less consequence than speed. "Where the question is that of practically controlling the working of some technical process it is often necessary to get quickly an idea of this from time to time; or it may be instantaneously wanted, even if the idea should be only a rough one."

For confining liquids the author prefers pure water wherever practicable, avoiding mercury as far as possible, and totally rejecting glycerin and the fatty oils.

The first subject discussed in the body of the book is sampling—a point of much nicety and involving far greater difficulties than the sampling of solids or liquids. The various appliances preferred for this purpose are described and figured.

The measurement of gases is next considered. Here a

needful caution is given concerning the maintenance of a uniform temperature in the laboratory. If artificial heat is necessary a stove—not an open grate—should be lighted the night before and kept up all the time so that the room itself, the reagents, the apparatus, the water, &c., should be all at the same temperature. Radiant heat is especially to be avoided.

The author then describes the apparatus and methods for conducting gas analysis. The two main methods are of course estimation by absorption and by combustion. Under the former head are included direct volumetric estimation, estimation by titration, and estimation by weight.

A very important section added by the Translator relates to gas analysis and gas volumetric analysis by the aid of his "nitrometer." A selection of useful tables completes the work.

We can only hope that now this excellent manual has become available for English readers the importance of technical gas analysis will be more widely recognised and its practice introduced among "works'-chemists."

Annual Report of the Board of Regents of the Smithsonian Institution: showing the Operations, Expenditure, and Condition of the Institution for the Year 1883. Washington: Government Printing Office.

It is a misfortune for this Report that it appears so long after date, whence the surveys of the progress of the sciences are rendered much less interesting than would be otherwise the case.

We notice an account of the unveiling of the statue of Prof. Henry. A discourse delivered on this occasion by President Noah Porter, of Yale College, is not entirely unobjectionable. Remarks on organic evolution were somewhat out of place in the eulogy of an eminent physicist. Dr. Porter, probably on the principle of being "thankful for small mercies," rejoices that American science has been so far kept free from the speculative audacities and the physiological cosmogonies from which the science of England and Germany has not been wholly exempt.

The rapid increase of the National Museum is a subject for congratulation. But unless we fail to understand pp. 6 and 7 a large portion of the space is taken up not by specimens from the three kingdoms of nature, but by manufactured goods.

Several scientific bodies hold their meetings in the premises of the National Museum. We may mention the National Academy of Sciences, the American Pharmaceutical Association, the Association of Wholesale Druggists, and the Anthropological and Biological Societies of Washington. The activity of the Institution in sending out or assisting in scientific exploring expeditions in various parts of the world merits the highest praise.

We find that the apparatus once used by Joseph Priestley, and since treasured up in his family, has been presented to the American nation, and is now safely lodged in the Smithsonian Institution.

A very striking fact is the attention evidently paid in America to meteorology and ethnology. The former branch of science occupies 86 pages in the report as against 30 assigned to chemistry, whilst anthropology occupies no fewer than 164.

Influence of the Composition of Glass upon the Changes of the Zero Point.—According to R. Weber, readily fusible alkali-lime glasses are the best suitable; pure potash glass containing a large proportion of silica is the most suitable. According to Wiebe, Abbe, and Schott, the zero point varies much more in glass containing an approximately equal proportion of potash and soda than when one of the two alkalis decidedly predominates. —*Zeitschrift für Analytische Chemie.*

CORRESPONDENCE.

SCIENCE IN THE LAW-COURTS.

To the Editor of the Chemical News.

SIR,—I am very glad to find that you are bringing this subject under the notice of the chemical profession and of the public. With the present system of obtaining evidence on technical issues no man, can, on due reflection, feel satisfied. Justice is delayed and rendered more costly, the time of the judges is wasted, juries are bewildered, and the unfortunate "expert" is placed in a most unpleasant predicament. As you say, however truthful he may be he is suspected of being a liar and treated accordingly. Now surely a method of procedure which causes men, perhaps as honourable and upright as the Judge on the Bench, to be thus accused, and which at all events formally tempts them to equivocation and to the suppression of truths, needs no further condemnation. The discussion that now takes place through the opaque medium of the examining and cross-examining counsel should take place at a meeting of experts *before* the trial, at which merely the final result should be given. Prof. Frankland's remark "that in no other civilised country is the expert precluded from acquaintance with both sides of the question before giving his opinion" must not be lost sight of.—I am, &c.,

TECHNICUS.

SCIENCE IN THE LAW-COURTS.

To the Editor of the Chemical News.

SIR,—Has it ever struck you that in trials for poisoning, adulterations, &c., chemists are frequently pressed to give an opinion on strictly medical points? Thus, they are asked to say whether the opinion of some particular symptom is consistent with the ingestion of a given poison. This, in my humble opinion, is a great mistake. A chemical expert, unless he is also a practising physician—which is very rare—should refuse to be led into a region with which he is not thoroughly acquainted.—I am, &c.,

R. P.

SCIENCE IN THE LAW-COURTS.

To the Editor of the Chemical News.

SIR,—With regard to the subject on which you have invited correspondence, I think that the past and present treatment of "Science" at the hands of "Law" is a crying grievance and calls for redress. Science is nothing if not judicial, she is admittedly qualified to weigh impartially the evidence which she extracts from Nature; surely, then, it is both her duty to ask and her right to obtain something more like the functions of a judge when her decision is sought in such paltry questions as form the themes of law-courts. Instead of "herding with thieves and scoundrels in the witness-box," or of stammering out a timid answer for some arrogant lawyer to distort, or even of descending to the special pleader's position of seeing only one side of the question and defending a half-truth in an "expert" manner, she ought to claim her rightful position on the bench or something closely analogous. Certainly the treatment accorded to science in the person of Dr. Angus Smith, a man who could bear comparison with any wearer of the ermine in the land, was very far from what it should have been.—I am, &c.,

JOHN STEVENSON.

December 19, 1885.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—The discussion at present taking place in your columns offers an appropriate opportunity for calling the

earnest attention of the Council of the Institute to what has always appeared to the writer, and to not a few others of his professional acquaintances, a weak point in the qualifications demanded from candidates for the Associateship. I refer to the compulsory three years' training in a school of science.

It appears to me that it would be amply sufficient if the Council required a candidate to pass satisfactorily adequate examinations, theoretical and practical, in chemistry, physics, and mathematics, without interference as to the mode and place of his training.

As a general rule, a three years' course in a science school, theoretically good as it may be, turns out a man whose work and manipulation are apt to be slipshod and generally unsatisfactory as compared with those of one who has spent a like time in a real working laboratory. So strongly is this felt to be the case that some of our best and most thorough analysts avoid taking assistants fresh from a college, preferring to train them themselves in their own laboratories. A young chemist who has spent three years in a practical laboratory engaged in real analytical work, is then able to earn his living, and his training and experience possess a realisable value. But a youth may (and often does) go through a three years' course at a science school, emerging from his studies a poor manipulator, untrained both in accuracy and quickness, altogether wanting in business-like habits, and practically worthless in a real laboratory until he has spent a *further* term of pupilage in qualifying himself for genuine work and responsibility.

I should here say that I am fully aware of the fact that many really qualified accurate chemists and good analysts are yearly turned out of some of our science schools: but I am convinced that the rank and file of college chemical students of three years' standing will not compare in chemical knowledge and capability with a pupil who has spent the same time in the study of his profession in the private laboratory of a chemist in good practice.

The objections raised by those who support the necessity of the college curriculum are, first, that a general scientific training in the theory of chemistry and physics is ensured, which forms no necessary part of the training in a private laboratory: and, furthermore, that even the practical work in a private laboratory has, in most cases, a tendency to become "specialised." To the latter objection, which holds good only in some cases, it might even perhaps be urged that a man who, trained even in an exclusively metallurgical laboratory, could make accurate and trustworthy analyses of ores and alloys, is a sounder and better man than one who could in an amateur way dabble inaccurately at a dozen different branches of analysis, and be unable to make anything like a really useful quantitative test in anything—for such, too often, is the result of the "practical" work in school or college. To the other objection I would urge that the man who spends his days in analysing ores or foods or water under the eyes of a qualified instructor does not necessarily neglect his "pure" chemistry and physics. If he is an earnest student he will find ample time and opportunity for theoretical study; and most of our larger educational institutions have good evening classes, not only in mathematics, physics, and theoretical chemistry, but even in practical chemistry of the more elementary kind. Surely a lad who, possessing an ordinary school knowledge of chemistry (say, including the elements of inorganic chemistry and the detection of one or two salts in solution), proceeds to the laboratory of a practising chemist, is articulated for three years, and who during that time qualifies himself to pass the examinations of the Institute, ought without hesitation be admitted to examination and granted the Associateship. Let the examinations be thorough and sound, but let there be no prohibitive or "permissive legislation" as to the exact course of study pursued. The degrees of the University of London hold rank second to none in the world, but the Senate prescribes no course of study. The possession of the necessary educational qualification for a degree is

considered sufficient; the manner and place of education is optional.

It has been frequently argued that the curriculum of a medical student is strictly laid down, and pointed out that in his case an apprenticeship or articulated assistantship to a surgeon supplemented by private study is *not* admitted to be a qualifying course of training. But the cases are not analogous. A medical student cannot dissect in the surgery of a medical practitioner. For this branch of his study alone it is necessary that he should enter a hospital; and furthermore, his master could not drag him about from home to home, to the bedsides of his patients, and then and there discourse to him of their ailments. Disease can *only* be properly studied in the wards of a hospital. With chemistry the case is altogether different.

But for those who seek an analogy or a precedent, I would instance the learned profession of the law. A would be solicitor is not only *not* required to have studied law in a college, but, after a preliminary examination to test his rudimentary school knowledge, he is absolutely *required* to spend five years as articulated clerk to a solicitor in practice. He studies when and how he pleases. All else that is demanded of him is that he shall be ready to pass his examinations at the proper time. All the cognisance that the legal examining body takes of college curriculum is embodied in the shortening of the term of articles by one or two years if the student, before entering on it, shall have obtained a University qualification. But even here it is the University qualification and not the actual University curriculum that counts.

I venture to consider that a far better analogy exists between the cases of the practising chemist and the solicitor than between that of the practising chemist and the surgeon; and to recommend the council most earnestly to consider whether it is really to the interest of our body either presently or prospectively to attempt to restrict or govern the course of study of those who should become the aspirants to its associateship. I advisedly use the word "attempt," because I feel that in a very great number of cases the extended yoke will be merely avoided and the student will get his education in the manner best and most readily attainable, as heretofore, though he may be (and this is the pity) without the inducement to work hard and well held out by the Institute's examination.

If any demand as to a "curriculum" at all is to be made, I would suggest that a "three years course of study of chemistry, physics, and mathematics," *to be approved by the Council in the case of each individual applicant for examination*, would be sufficient meet all purposes; but certainly far more latitude should be accorded to candidates than has hitherto been allowed.

I fear I have occupied a good deal of your space, but the matter is one which, I think, has not been sufficiently discussed. I write as one who has for a number of years conducted a varied and busy practice, both analytical and consulting; as one who has had considerable experience with students, pupils, and assistants; and as one who knows that in this letter he is expressing not only his own views but those of other practitioners whose experience and judgment are entitled to respect.—I am, &c.,

A PRACTISING FELLOW OF THE INSTITUTE.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—Many will thank you for opening your columns for the discussion of the doings of the Council of the Institute of Chemistry. Some who have written on the subject appear to have rushed into print rather too hastily. However easy it may have been in the past to procure sanction to use "three comparatively unknown letters" at the end of a name, it is by no means so easy now.

There are many who wish to be associated with the

Institute, but the doors are closed to them. In fact, the very class whom it intends to benefit most are politely ignored, and what the council says practically amounts to this—as a former correspondent pointed out—we can now only recruit our ranks by students from the laboratories of certain colleges (twenty in number) which we have placed on our prospectus. Men gaining their livelihood as chemists, and who are willing to submit themselves to any test examinations the Institute may deem necessary, are told that the Council decline to treat with them, because the "evidence of training" is not sufficient. Of what use is their own examinations if they be not evidence sufficient? Surely common sense should indicate that this state of matters should be altered.

Mine is not an isolated case, and I give it just to show that there is good reason for complaint against the present system of entrance, and also to show how *chemists* may expect to be treated if they should attempt to approach this learned association.

I spent five years in the acquirement of a thorough knowledge of chemistry, two of which were spent at colleges named on the prospectus of the Institute. I have held the position of chemist for a considerable time in a first-class London laboratory, where the work is of various and responsible nature. I had the pleasure of reading Professor Odling's address, and it occurred to me I should like to be connected with the Institute, and wrote for a prospectus. I stated to the secretary my willingness to be examined in the subjects set forth in the prospectus, and giving full particulars. In return, I had a brief acknowledgment to the effect that the "Council insisted upon the evidence of a course of three years' training." So I suppose before I can sit to be examined I must leave my post, and go back to be *prepared* at one of the colleges they have selected. Not very likely. I have got on very well in my profession so far without the A.I.C. or F.I.C., and shall never feel the want of either.

I should say by no means abolish the examinations, as some propose. The present system of "evidence of training" is sheer humbug, and calls for immediate reform. The sooner the Council throw open their examination doors to all comers, irrespective of what college they have attended, or what certificates the candidates hold, the better, otherwise the much vaunted Institute will go to the dogs, and all sensible men will wish it a speedy journey.—I am, &c.,

FERRUM.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ci., No. 22, November 30, 1885.

This issue contains merely the discourses pronounced at the funeral of the President, M. Henri Bouley, who died on the morning of Nov. 30.

No. 23, December 7, 1885.

The Absorption Spectrum of Oxygen.—N. Egoroff.—The author has succeeded in showing that all the rays of the groups A, B, and α , 126 in number, belong to oxygen.

On the Characteristic Equation of Carbonic Acid.—E. Sarrau.—A mathematical paper not admitting of abstraction.

Process for Preparing Vanadyl Chloride.—L. L'Hôte.—Ground vanadite is mixed with 4 parts by weight of lamp-black. The mixture is made into a paste

with oil, calcined, and treated in heat with a current of dry chlorine. The chlorine, after being washed with water and dried by passing over pumice moistened with sulphuric acid, enters a tube of green glass containing the calcined product and placed in an oil-bath of especial arrangement. The extremity of the green glass tube is connected to U-tubes placed in freezing mixtures. When the apparatus is filled with chlorine the oil-bath is cautiously heated and the vanadyl chloride begins to distil over about 210° ; the temperature is then raised to 300° . The vanadyl chloride forms a liquid of a gold colour, very volatile, and giving off reddish fumes. Its sp. gr. at 18° is 1.854 and its boiling-point is 126.5 .

Preparation of Hypophosphoric Acid.—A. Joly.—An account of barium monophosphate.

Combustion-Heat of Certain Ethers of Organic Acids.—M. Louguinine.—The author's experiments relate to the ethyl-ether of lactic acid, to citric normal ethyl-butyric, and ethyl-isobutylic ether.

Pyrogenous Decomposition of Acids of the Fatty Series.—M. Hanriot.—Succinic, adipic, lactic, and pyruvic acids are split up in a very simple manner, giving off carbonic acid. Glycolic acid resists almost up to a red heat and then undergoes a very profound decomposition.

Normal and Primary Monochlorised Butyric Compounds.—Louis Henry.—Not susceptible of useful abstraction.

Analysis of the Deposit formed by the Water of Chabetout.—M. Thabuis.—In this deposit arsenic is combined with iron as a basic arseniate, whilst the phosphorus exists in combination with calcium as a phosphate.

Zeitschrift für Analytische Chemie.
Vol. xxiv., Part 4, 1885.

The Application of Sodium Bromate in Volumetric Analysis.—Dr. Kratschmer.—Sodium bromate in presence of a mineral acid liberates from potassium iodide—if the latter is present in solution in sufficient quantity—a quantity of iodine exactly equivalent to its proportion of oxygen. As especial experiments prove, the addition of hydrochloric, sulphuric, nitric, or phosphoric acids in a dilute condition gives similar results. Hence sodium bromate may be substituted for iodine in volumetric analysis. For eyes sensitive to colour the addition of starch paste for detecting the end of the reaction may be regarded as superfluous.

Separation of Picrotoxine from its Solutions.—R. Palm.—Solutions containing picrotoxine give with basic lead acetate and Dzondi's liquor precipitates which, on treatment with strong sulphuric acid, assume yellow, orange, or reddish violet colours. All the samples of picrotoxine on closer examination were found to contain fatty acids and other impurities which give a similar reaction. The reaction was produced as follows:—The solution of picrotoxine in water or alcohol was mixed first with basic lead acetate and then with alcoholic ammonia until the supernatant liquid was perfectly free from bitterness. But such freedom from bitterness is found to depend not on the total precipitation of the picrotoxine but on its decomposition by ammonia. The separation of picrotoxine from its solutions is therefore effected as follows:—A weighed quantity of pure picrotoxine (free from fatty acids) was dissolved in pure water and another portion in alcohol. Both solutions were mixed with freshly precipitated lead hydroxide and persistently shaken with the application of a gentle heat. The filtrate was perfectly free from bitterness, and, on evaporation, left not a trace of organic matter. The lead hydroxide remaining on the filter, after pressure between blotting-paper, gave with sulphuric acid the picrotoxine-reaction very distinctly. Digitaline and solanine resemble picrotoxine in their behaviour with lead hydroxide. The compound of

lead hydroxide with digitaline is turned by sulphuric acid a flesh-colour or a light chamois, but on long standing in contact with bromine or potassium bromide it turns to an emerald-green. The compound of solanine with sulphuric acid is a dark chamois, which gradually turns violet, and ultimately blue on treatment with sugar.

Methods of Fractionated Distillation.—G. Lunge.—The best apparatus for the fractionation of bodies boiling below excessive temperatures are Linnemann's wire-gauze top-piece and Hempel's boiling tube, the latter being in most cases preferable.

On Standardising Permanganate Solutions.—G. Krüss.—The author proceeds by means of quantitative spectrum analysis, and gives tables for this purpose. The method is applicable to all coloured reagents.

The Production of Iodide Coatings.—E. Haanel, and Wheeler and Ludeking.—From the CHEMICAL NEWS.

Process for the Stratification of Liquids.—A. Handl.—The specifically heavier liquid is introduced below the lighter one by means of a syphon connected by means of a caoutchouc tube with a glass tube drawn out to a point. The syphon is filled with the denser liquid, closed by means of a pinchcock on the caoutchouc tube; the point is plunged down to the bottom of the vessel containing the lighter liquid, and the pinchcock is opened. The heavy liquid then flows down to the bottom.

An Apparatus for Washing with Liquids not Miscible with Water.—M. Goldstein.—This paragraph requires the accompanying figure.

Self-closing Gas-burners.—Julius Schober and R. Muencke.

A New Vaporimeter.—G. T. Gerlach.—This paper also cannot be intelligibly reproduced without the annexed illustration.

A New Gas Muffle Furnace.—Walter Lee.—From the CHEMICAL NEWS.

Two Small Laboratory Appliances.—R. Richter.—All these papers require the accompanying figures.

Soluble and Volatile Filters.—F. A. Gooch.—The author proposes, as a suitable material, anthracene, which is readily soluble in benzol, ether, boiling alcohol, but insoluble in water, saline solutions, alkalies, and dilute acids. He moistens the anthracene with a little alcohol, stirs it up in water, and pours the emulsion into a crucible with a perforated bottom, upon which the anthracene is deposited, just like the asbestos in the author's asbestos filter.

Deterioration of Caoutchouc Tubes, Stoppers, &c.—C. A. Burghardt.—The change in question is a process of oxidation.

Free or Excessive Sulphur in Caoutchouc Tubes.—M. Limousin.—This deposit of sulphur may occasion explosions in contact with hot oxygen. The author recommends that new tubes should be scraped out and washed.

Boric Acid in Alkalimetry.—A. Guyard.—Boric acid can easily be obtained pure by re-crystallisation, and rendered anhydrous by means of ignition. He recommends hæmatoxyline as indicator. A. Levin remarks that the end of the reaction with boric acid is not distinctly shown either by hæmatoxyline, litmus, or any of the recently proposed indicators.

Preservation of Litmus Tincture.—R. Kissling adds sodium salicylate, or neutralises with salicylic acid instead of with sulphuric acid.

The Detection of Hydrogen Peroxide.—Schœnbein's test requires that the solution should be neutral. M. Traube finds that the reaction loses nothing of its sensitiveness in very acid solutions if a small quantity of copper sulphate is present. If to 6 to 8 c.c. of a solution containing traces of hydrogen peroxide we add sulphuric acid and zinc-iodide starch, and then one drop, or at most

four drops, of a 2 per cent solution of copper sulphate, and, lastly, a little of a $\frac{1}{2}$ per cent solution of iron sulphate, the blue colouration appears in a few seconds. The order of mixing the ingredients is essential.

Separation of Zinc from all Metals of the same Group.—W. Hampe.—(See p. 313.)

On a New Method for Determining Manganese in Spiegeleisen, Ferro-Manganese, and Ores.—W. Kalman and Alois Smolka.—This paper also will be inserted *in extenso*.

The Solubility of Manganese Ferricyanide in Hydrochloric Acid.—L. M. Deane.—From the CHEMICAL NEWS.

A New Method for Separating Nickel and Cobalt.—M. Ilinski and G. von Knorre.

On the Analysis of Iron Ores.—Walter Hempel.—For opening up these ores the author recommends the following process, which is at once complete, brings all the iron into the ferric state, and destroys any organic matter. The ores are finely powdered, air-dried, and about 0.3 grm. is weighed off for analysis. The weighed portion is ground up in an agate mortar with 0.4 grm. soda, free from iron, and thoroughly mixed with 2 grms. precipitated calcium carbonate free from iron. The mixture is placed in a platinum crucible and ignited for an hour in a furnace with the author's oxidising arrangement. When cold the frit is gently lifted out of the crucible with a glass or platinum spatula and introduced into a wide-necked flask. The residue adhering to the crucible is rinsed into the flask with strong hydrochloric acid, and the whole is boiled. In a few minutes all the iron passes into solution. When the iron is dissolved the boiling is kept up for five minutes longer to bring any manganese present into the state of manganous chloride, the liquid is slightly diluted and titrated with stannous chloride. If the calcium carbonate available is not free from iron its proportion of iron is first determined in the same manner.

A New Method for Separating Copper and Cadmium.—P. Gucci.—To the liquid from which bismuth has been removed by an excess of ammonia, and which contains copper and cadmium, there is added hydrochloric, nitric, or sulphuric acid until the hydroxides of both metals are completely re-dissolved. A slight excess of a 10 per cent. solution of ammonium benzoate is then added, when copper benzoate is deposited. The filtrate contains the cadmium. The dried copper benzoate is determined as copper oxide by ignition in a crucible, moistening with nitric acid, re-ignition, and weighing. The process gives very accurate results even when little cadmium occurs along with much copper.

The Detection of Traces of Nitrous, Hyponitrous, and Nitric Acids.—H. Hager.—The author pours 2 to 4 c.c. of the liquid in question into a test-tube about 12 centimetres in length, and if the acids are not in a free condition he adds 1 to 2 c.c. of strong sulphuric acid. In the mouth of the test-tube he places a cornet of filter-paper, about 5 centimetres in length, the point of which has been dipped either in solution of potassium iodide, or of zinc iodide mixed with starch-paste. The cornet must close the test-tube, and its point should lie in the axial line. If the liquid in the cylinder is heated or boiled the point of the cornet will become coloured.

A Reaction of Atropine and its Kindred Alkaloids.—A. W. Gerrard.—If an alcoholic solution of atropine is mixed with an aqueous solution of mercuric chloride there is formed a yellow precipitate of mercuric oxide which turns red on boiling. This reaction is common to atropine, hyoscyamine, daturine, duboisine, and homatropine. Upon other alkaloids mercuric chloride has no similar action.

Coloured Reactions of the Phenols with the Carbohydrates.—A. Ihl.—This paper will be inserted in full.

The Determination of the Molecular Weight and the Atomicity of the Higher Fatty Alcohols.—Carl Hell.—The author utilises the reaction which occurs on heating such alcohols with soda-lime, *i. e.*, their conversion into acids containing the same quantity of carbon with liberation of hydrogen.

The Determination of the Halogens and of Sulphur in Organic Substances.—C. Julkowsky and Carl Lepéz.—This memoir requires the four accompanying illustrations.

The Determination of Halogens in the Lateral Chains of Aromatic Compounds.—L. P. Kinnicut and R. S. Sweester.—The authors find that Schulze's method (*Zeits. Anal. Chemie*, xxiv., 104) is not universally applicable.

A Reaction of Glucose and Milk-Sugar.—Max Rubner.—If lead acetate is added to a diluted solution of glucose, ammonia dropped in until a permanent precipitate appears and heat applied, the precipitate turns rose- or flesh-coloured. With milk-sugar a yellow or flesh-colour appears on prolonged boiling. Cane-sugar and dextrin do not give this reaction.

Behaviour of Glycerin with Fehling's Solution.—H. Endemann.—If glycerin is diluted with a little water, and boiled for ten minutes with Fehling's solution, there is a slight reduction. Glycerin does not interfere with the reaction of sugar simultaneously present.

MISCELLANEOUS.

The late Mr. E. O. Brown.—The many scientific friends of the late Mr. Brown, of Woolwich Arsenal, will regret to hear that his family is very badly provided for, as beyond the investment of some special sums received for his work in connection with gun cotton, he was unable to save, and the exorbitant premium asked for the insurance of his life prevented him providing for his family by that means. Sir Frederick Abel and others are forming a small committee to raise a fund for the object of affording some aid to Mrs. Brown, who has four young children unprovided for. We shall be glad to receive the name of anyone who would be willing to co-operate with the committee. Any sums of money entrusted to us for this purpose will be duly acknowledged in the CHEMICAL NEWS, and in the absence of special instructions from the donors will be applied as the committee think most advantageous for the family.

MEETINGS FOR THE WEEK.

MONDAY, 28th.—London Institution, 5.
TUESDAY, 29th.—Royal Institution, 3. "The Story of a Meteorite," by Prof. Dewar.
THURSDAY, 31st.—Royal Institution, 3. "The Story of a Meteorite," by Prof. Dewar.
— London Institution, 7.
FRIDAY, Jan. 1st.—Geologists' Association, 8.
SATURDAY, 2nd.—Royal Institution, 3. "The Story of a Meteorite," by Prof. Dewar.

TO CORRESPONDENTS.

D. Y. J.—We are unable to give the recipe required.

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